G/GVAR-0019

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4-30

GSEG NO. 1

OPERATIONAL VAS MODE AAA FORMAT

SPECIFICATION SFP 002

This document defines the NOAA/NESDIS Operational VAS Mode AAA Format
September 1987. Version 2.5A

NOTE: The dark lines in the right margins identify the areas of the document that have been revised since the release of the SFP 002, Version 2.5 (February, 1987).

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This document defines the NOAA/NESDIS Operational VAS Mode AAA Format

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UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL ENVIRONMENTAL SATELLITE, DATA, AND INFORMATION SERVICE
Washington, D.C. 20233

TO : Stretched VISSR/VAS Users and Manufactures

SUBJECT: OPERATIONAL VAS MODE AAA FORMAT VERSION 2.3

The enclosed document, "Operational VAS Mode AAA Format," defines the new Geostationary Operational Environmental Satellite (GOES) retransmit data format that is to be made operational in early 1987. The attached version contains all corrections, modifications, additions, and deletions since the release of version 2.2 in May 1985.

Aside from the minor corrections or clarifications highlighted in the margins throughout the document, the following changes have been made:

a. The ground system equipment responsible for generating each word is identified.

b. The third common documentation field was revised and updated to reflect actual visible, IR, and detector geometry data sets (number of spares available has been changed). Also, some of the equations have been corrected.

c. Two additional appendices have been added: describing Auxiliary Product Transmissions (Appendix E) and providing a Mode AAA to Mode A Conversion Table (Appendix F).

Currently Mode AAA is undergoing its test phase. As incompatibilities arise with existing operational equipments and between the new ground systems equipments other changes to the format are likely. NESDIS will make revisions to the format as needed whenever this type of event occurs. If you have specific questions concerning this document please do not hesitate to contact Warren F. Dorsey at (301) 763-8064. If you have any suggested modifications or enhancements to the format, they should be forwarded, in writing, to:

NOAA/National Environmental Satellite, Data, & Information Service
Office of Systems Development, GSEG
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Washington D. C. 20233
ATTN: Warren F. Dorsey

In closing we would like to thank all users; especially the PROFS facility at ERL in Boulder, Colorado; for assistance during our testing of the Operational VAS Mode AAA Format. For current updates concerning the scheduling of Mode AAA tests and implementation, please consult the NOAA/NESDIS bulletin board.

TABLE OF CONTENTS

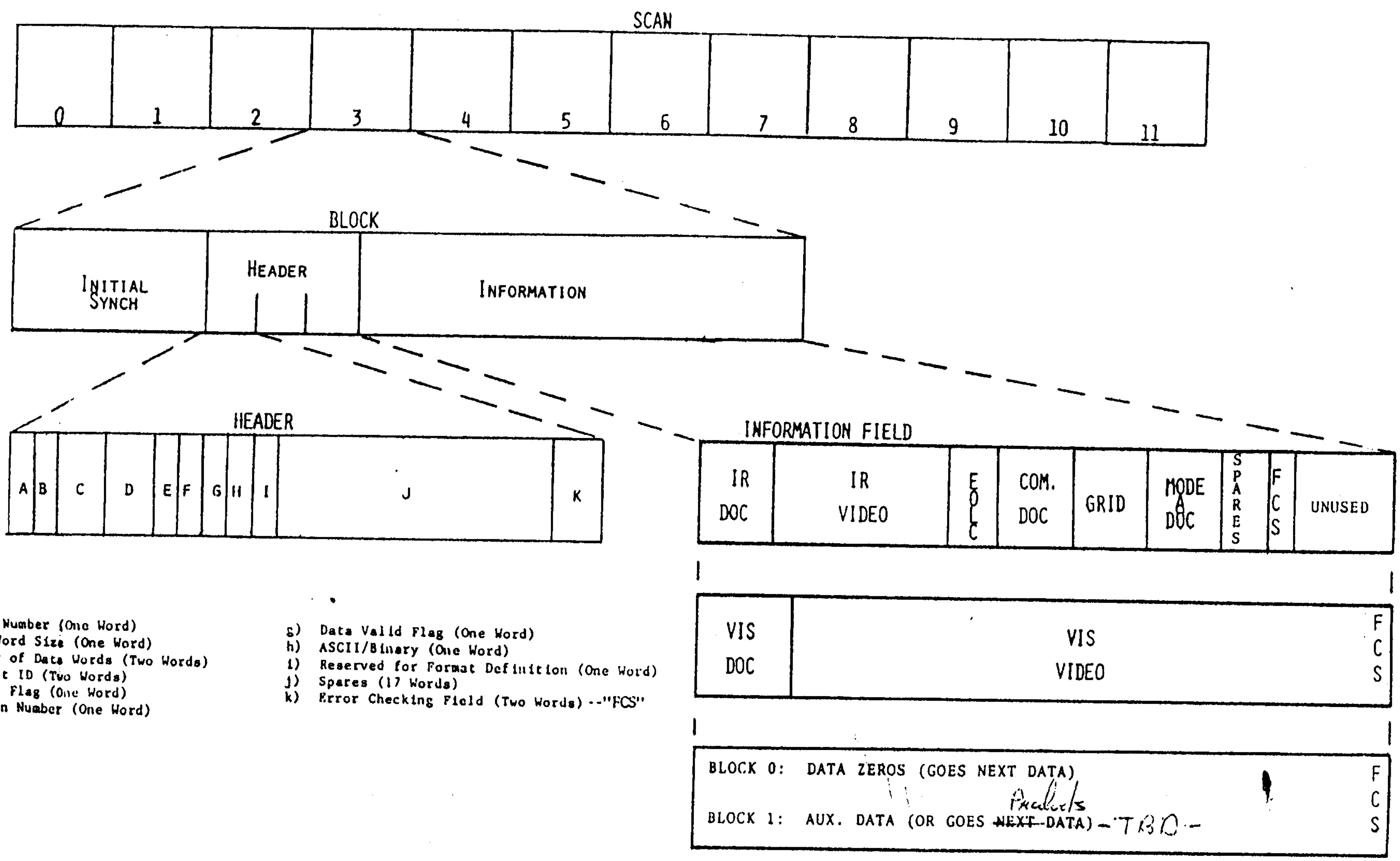
1.0 INTRODUCTION

This document defines the format of the meteorological data and associated parameters relating to the GOES Visible and Infrared Spin Scan Radiometer Atmospheric Sounder (VAS). The format described herein is refered to as Mode AAA or triple A to distinguish it from two formats, Mode A and Mode AA, used earlier in the GOES program. Mode AAA format is shown diagrammatically in Figure 1.

Remotely sensed measurements made by the GOES VAS are transmitted to the National Oceanic and Atmospheric Administration (NOAA) Command and Data Acquisition (CDA) station at Wallops Station, Virginia. At the CDA station, the visible and infrared data are reformatted, calibrated, gridded and then transmitted, relayed via the GOES, at a reduced data rate, to receiving stations remotely located from the CDA station. It is the format of this reduced rate VAS data, refered to interchangeably as stretched VAS (SVAS) and Mode AAA, that is defined in this document.

NOTE: The OPERATIONAL VAS MODE AAA FORMAT is generated by the GOES Processor/Distribution Unit (P/DU) situated at the NOAA/NESDIS Command and Data Acquistion (CDA) Station, Wallops Station, VA. Although the P/DU generates the format, the GOES VAS Image Processor (VIP) inputs calibrated VIS and IR video data and the respective VIS and IR documentation words. The VIP also transfers many of the common documentation data words. Throughout this document the role of each of these GOES systems in generating this data format is further clarified. The central controller for these new equipments is called the GOES Monitoring and Control System (GMACS).

Whenever the VAS Digital Multiplexer (VDM) is commanded OFF, (i.e. after every Synoptic Frame (Full Disk Image) in either VAS or VISSR Mode) the P/DU will output the VIP's last scan of documentation data until the VDM is commanded back ON. This is done to provide a higher quality WEFAX transmission.



a) Block Number (One Word)
b) Data Word Size (One Word)
c) Number of Data Words (Two Words)
d) Product ID (Two Words)
e) Repeat Flag (One Word)
f) Version Number (One Word)
g) Data Valid Flag (One Word)
h) ASCII/Binary (One Word)
i) Reserved for Format Definition (One Word)
j) Spares (17 Words)
k) Error Checking Field (Two Words) --"FCS"

MODE AAA RETRANSMISSION FORMAT - FIGURE 1

MODE AAA RETRANSMISSION FORMAT

SCAN

Period	600 msec nominal
Blocks/Scan	12
Bit Rate	2,111,360 b/sec.

BLOCK

Period	50 msec nominal
Sync Length	10032 bits
Header Word Length	8 bits/word
Header Length (triple redundant)	90 words (720 bits)
Information Field Word Length	6, 8, or 10 bits/word
Information Field Length	94816 bits

INFORMATION FIELD

IR Block	
Word Length	10 bits/word
IR Doc. Length	16 words (160 bits)
IR Video	3822 words (38220 bits)
EOLC	8 words (80 bits)
Common Doc.	512 words (5120 bits)
Gridding Info.	1024 words (10240 bits)
Mode A IR Doc.	128 words (1280 bits)
Spare	384 words (3840 bits)
FCS	2-8 bit/word (16 bits)
UNUSED	3586 words (35860 bits)
VIS Block	
Word Length	6 bits/word
VIS Doc.	512 words (3072 bits)
VIS Video	15288 words (91728 bits)
FCS	2 - 8 bit words (16 bits)
Aux Data Block	
Word Length	6, 8, or 10 bits/word
FCS	2 - 8 bit words (16 bits)
Length	94816 bits

2.0 SCAN FORMAT

The format of one scan of Mode AAA is shown in Figure 2. It is a concatination of 12 equal duration "Blocks" of which the total period, 600 miliseconds, corresponds to the nominal period of one spacecraft revolution. Consequently, each block is nominally 50 milliseconds duration and corresponds to 30 degrees of spacecraft rotation. The retransmission scheme is such that eight blocks each contain data from one of the VAS instrument's visible sensors, two blocks each contain data from one of the VAS instruments infrared sensors, one block contains auxiliary data from any of several ground system sources, and one block referred to as the Earth View block contains data zeros in the Mode AAA design. However, future systems may utilize this block as well for data transmission.

When the raw VAS data is transmitted from the satellite at a 28Mb/sec rate, the transponder's receiver is squelched. To avoid loss of data, the retransmission of SVAS must be timed so the Earth View block arrives at the spacecraft coincident with the receiver squelch period. For the current GOES satellites the receiver squelch period can occur from -12.6 degrees to +10.6 degrees for a total of 23.2 degrees. This is well within the 30 degrees allocated for the Earth View block in the AAA format. The retransmission timing will be such that the transponder squelch period terminates 3 1/3 to 5 msec (2 to 3 degrees of spacecraft rotation) before the beginning of the Block 1 synchronizing period.

2.1 Bit Rate

The nominal bit rate of the retransmitted data is 2,111,360 bits per second. Because of the "Equal Angle" sampling method used to format the VAS data, the number of samples per scan line is constant regardless of the satellite spin rate. Therefore, as the spin rate may vary within a ±5 RPM tolerance, the bit rate varies in direct proportion.

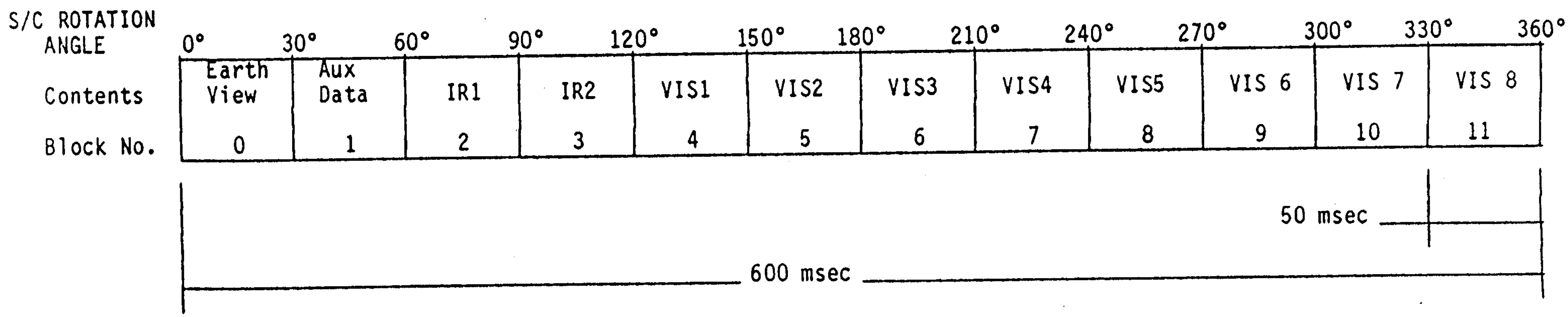


FIGURE 2 - MODE AAA VAS RETRANSMISSION SCAN FORMAT

2.2 Retransmission Delay

The precise timing of the data retransmission depends on the propagation delay between the spacecraft and the ground equipment at the CDA station and the satellite spin rate. Depending on the location of the satellite, the oneway transit time will be between 120 milliseconds and 136 milliseconds.

Figure 3 depicts the data retransmission timing. The shortest turnaround time to retransmit the data occurs when both the propagation delay and the satellite spin rate are maximum.

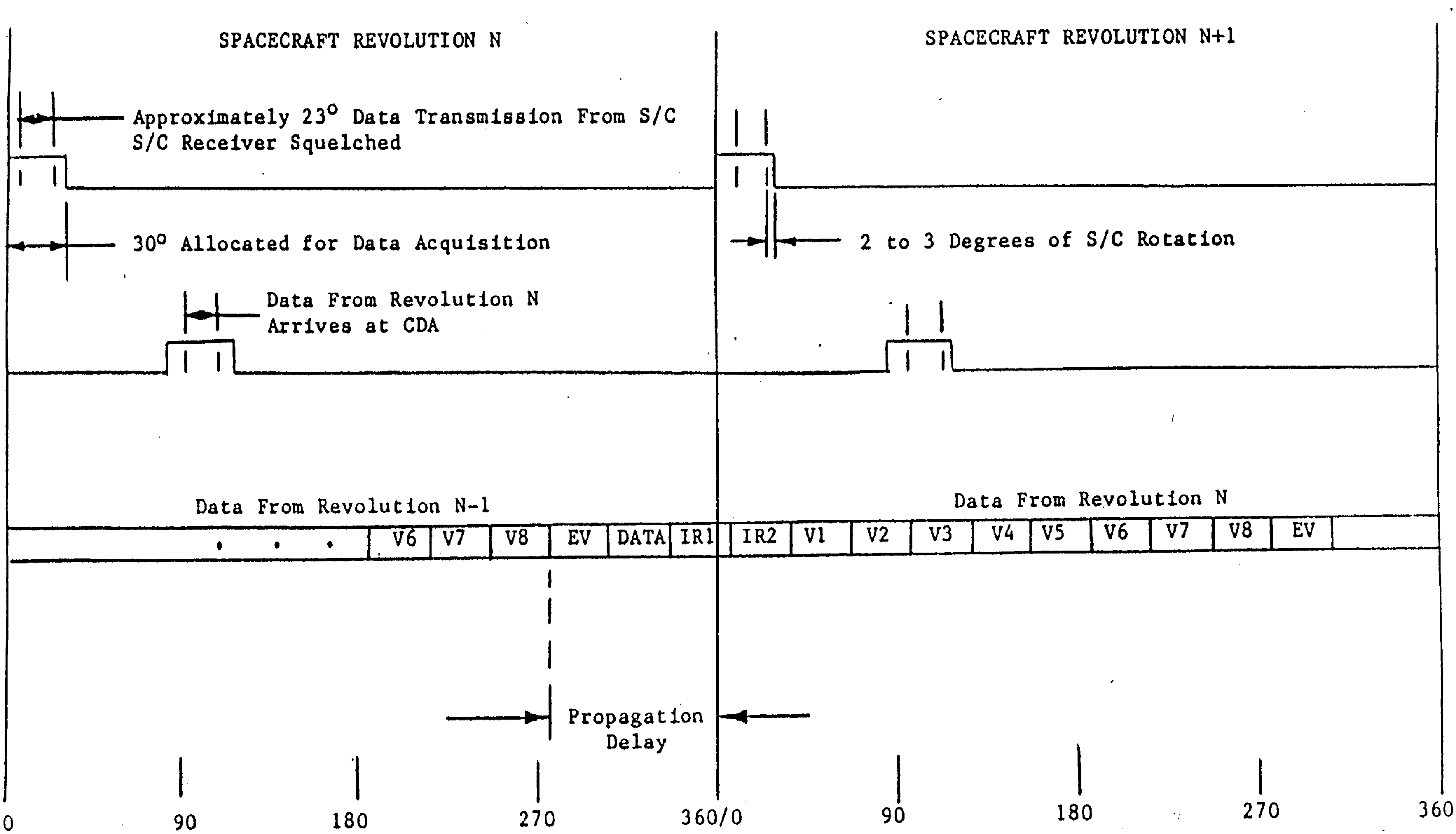
On any given spacecraft revolution, say revolution N, the data (raw VAS) will arrive at the CDA at a time corresponding to the propagation delay after it was transmitted. The data is stored on the ground and retransmitted at a time such that the "Earth View Block" in the retransmission format arrives at the spacecraft to overlap the receiver squelch period. The receiver squelch period terminates 2 to 3 degrees of spacecraft rotation prior to the start of the following block sync.

As a result of this timing, data acquired on revolution N of the spacecraft, is relayed by the spacecraft during revolution N+1.

2.3 Encoding

Prior to biphase modulation, the data to be retransmitted undergoes three stages of encoding. The encoding stages are described below and shown diagrammatically in Figure 4.

a) All even numbered eight bit bytes (regardless of word length) are complemented; the first byte following initial synchronization is one.
b) The second stage involves Pseudo-random Noise (PN) coding. The PN sequence is generated by a shift register whose input is the output of an exclusive-OR gate as shown in Figure 4. Bits eight and 15 (MSB) of the shift register are



SPACECRAFT ROTATION ANGLE
FIGURE 3 - ACQUISITION AND RETRANSMISSION TIMING

the inputs to this gate. The output of the gate is combined with a data line using a second exclusive-OR gate.

c) The PN coded data stream described above is passed through an NRZ-S differential encoding process. This process produces a transition for each logic zero input and none otherwise.

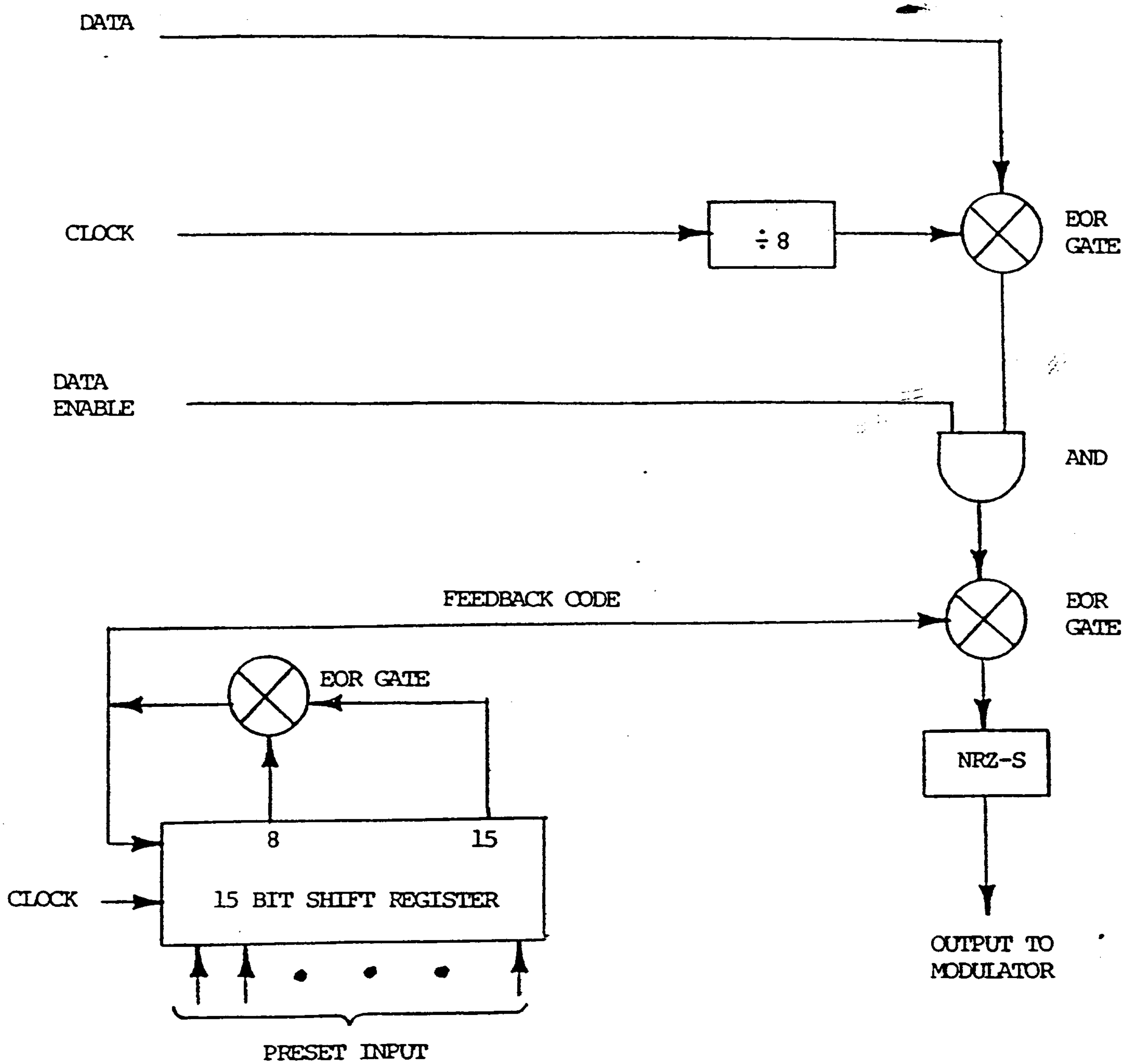


FIGURE 4. SYNCHRONIZATION ENCODING

3.0 BLOCK FORMAT

All blocks numbered zero through eleven are transmitted using a common format. That is, each block contains the following major fields:

a) Initial Synchronization Field
b) Header Field
c) Information or Data Field

The block format is shown in Figure 5.

Although the block format is defined in terms of eight bit words, the information field is a multiple of six, eight and ten bit words and can therefore be filled with words of those lengths.

CK

INITIAL SYNCH 1254 EIGHT BIT WORDS	HEADER 90 EIGHT BIT WORDS	INFORMATION & FCS UP TO 94816 BITS

HEADER

a	b	c	d	e	f	g	h	i	j	k

TRANSMIT THREE TIMES

a) Block Number (One Word)
b) Data Word Size (One Word)
c) Number of Data Words (Two Words)
d) Product ID (Two Words)
e) Repeat Flag (One Word)
f) Version Number (One Word)

g) Data Valid Flag (One Word) = Frame Code (Blocks 2-11)
h) ASCII/Binary (One Word)
i) Reserved for Format Definition (One Word)
j) Spares (17 Words)
k) Error Checking Field (Two Words)

FIGURE 5 - BLOCK AND HEADER FORMATS

3.1 Initial Synchronization Field

At the start of each block of the retransmission, the bits prior to the header are provided as a synchronization code. This code, for each block is a pseudorandom noise (PN) sequence generated as described in paragraph 2.3 b) and shown in Figure 4. The exclusive-OR of the data line and the complementing circuit is disabled during the initial synchronization period. The shift register is preset to 51665 octal so the contents (15 bits) are a logic one during the final bit period of the initial synchronization sequence. If this final bit period is given number zero and preceding bits are given negative numbers, etc., the bit sequence out of the first exclusive-OR gate and hence into the LSB of the shift register is:

Bit Number	-5					0										10
Logic Level	1	1	1	1	1	0	0	0	0	0	0	0	0	1	1	1

NOTE: At the receive site the downlink signal is converted by EXOR2 which is the replica of EXOR1 but is delayed one bit time. This occurs because of the inverse NRZ-S operation required.

3.2 Header Field

The "Header" consists of a field of 30 eight bit words containing block number, information pertinent to the contents of the information field which follows the header and an error check field. The header is transmitted three times to ensure error free reception. The most significant bit of the most significant word is transmitted first. The most significant bit is bit 1 with the least significant bit designated as bit 8.

Chart 1 and Table 1 depict the organization and describe the contents of the header field.

CHART 1. HEADER FIELD

GENERATED IN TOTAL BY THE P/DU

MSB 1	2	3	4	5	6	7	LSB 8

Byte	Field
1	BLOCK NUMBER
2	DATA WORD SIZE
3–4	NUMBER OF DATA WORDS
5–6	PRODUCT IDENTIFICATION
7	REPEAT FLAG
8	VERSION NUMBER
9	DATA VALID FLAG
10	ASCII/BINARY
11	RESERVED
12	SPARE
. . .	. . .
28	SPARE
29–30	ERROR CHECK

TABLE 1. MODE AAA HEADER CONTENTS

WORD NUMBER	CONTENTS	DESCRIPTION
1	Block Number	An eight bit binary number used to identify each of the twelve blocks of a scan. The block numbers are sequential except for block zero which is a special number designed to help some equipment identify block zero in the presence of bit errors. The block numbering is as follows: Block 0 = Binary 240 Block 1 = Binary 1 Block 2 = Binary 2 . . . . . . Block 11 = Binary 11
2	Word Size	An eight bit binary number that indicates the size (bits per word) of the words in the data field. Three examples follow: <u>Word Size</u> <u>Code</u> 6 bits Binary 6 8 bits Binary 8 10 bits Binary 10
3,4	Number of Data Words	A sixteen bit binary number that indicates the number of data words in the data field. This includes the sixteen bit error check field as two 8-bit words. Hence, an empty data block will contain two words.

TABLE 1. MODE AAA HEADER CONTENTS (Cont.)

WORD NUMBER	CONTENTS	DESCRIPTION
		<u>Number of Words</u> — <u>Code</u> 0 words — Binary 0 1 word — Binary 1 . — . . — . . — . 15,802 words — Binary 15,802
5,6	Product ID	A sixteen bit binary number that is used to identify products. A partial listing of products identifiers follows: Binary 0 = No data Binary 1 = Infrared data Binary 2 = Visible data Binary 15 = Avg. Sounding Prod. For other assigned aux. products (see Table E-1, p. E-2)
7	Repeat Flag	An eight bit word that indicates whether the data being transmitted is new data or is a repeat of data that was previously transmitted. Binary 0 = Repeat transmission Binary 1 = New data
8	Version Number	An eight bit binary number that indicates one variation of a product as opposed to other possible variations.

TABLE 1. MODE AAA HEADER CONTENTS (Cont.)

WORD NUMBER	CONTENTS	DESCRIPTION
		Version / Code 1 — Binary 1 2 — Binary 2 . — . . — . . — . 7 — Binary 7
9	Data Valid (Frame Code for Blocks 2-11)	A flag that indicates whether the data being transmitted is usable data or only "filler." Binary 0 = Filler Binary 1 = Valid data
10	ASCII/Binary	A flag that indicates the structure of the data in the data field to be ASCII or Binary. Binary 0 = Binary Binary 1 = ASCII
11		Reserved for future use to further define data formats.
12-28		Spare Words
29,30	Error Check Field	A sixteen bit error checking field used to validate transmission accuracy of the header information.

3.3 Information Field

The information fields of the 12 blocks in a scan all have the same maximum length, 94,816 bits. In general, an information field may contain any type of information, (the information type will be identified in the header). The actual length of the portion of the field in use may be varied and is also stated in the header. At the end of valid data all information fields will contain the error check field defined below.

The following sections describe the contents of the information fields when being used in the stretched VAS retransmission mode, Mode AAA.

3.3.1 Block 0

Because the Earth View block coincides with the transponder squelch period, no data is retransmitted during that period (only FCS words). However, the squelch period terminates several milliseconds, 2 to 3 degrees of satellite rotation, prior to the synchronization sequence for the following block. Therefore, by transmitting a PN sequence during this time the ground receiving systems will have additional time for carrier acquisition and bit synchronization. Consequently, like any unused block, the information field in the Earth View block will contain data zeros. Hence, even numbered eight bit bytes will be complemented, PN and NRZ-S encoded like all other blocks.

NOTE: The number of data words indicated in the header will be output as two, to include the 2-byte FCS field-- the data will be all zeros.

3.3.2 Block 1

The information field of the Auxiliary Data block will contain information in six, eight or ten bit words, even numbered eight bit bytes will be complemented and any space not filled with data will be filled with data zeros.

3.3.2.1 Error Check Field

Following valid data in the auxiliary data block will be the "Frame Check Sequence" (FCS) as described below.

The error detection method involves a cyclic-redundancy-check (CRC). The process is an algebraic procedure based on module 2 division using a generator polynomial to generate and check the "Frame Check Sequence" (FCS).

At the transmitter, the initial remainder of the division is preset to 16 ones. After the all ones preset, the initial remainder is then modified by division by the generator polynomial. This division is performed on the contents of the field being checked. When the field has completed the division process, the ones complement of the resulting remainder is transmitted as the 16-bit FCS.

At the receiver, the initial remainder is preset to all ones and the same division process takes place on the serial incoming bits. In the absence of transmission errors the final remainder is the hexidecimal constant F0B8 (1111 0000 1011 1000).

The generator polynomial shall be that polynomial specified by CCITT recommendation V41 and is: $x^{16} + x^{12} + x^5 + 1$, (1000 1000 0001 0001).

3.3.3 Blocks 2 and 3

The contents of the information fields of the Infrared blocks are similar to that transmitted in the earlier, Mode A or Mode AA, format. Although some of the information in the documentation portion of the data may be somewhat redundant with information in the header of the triple A format, that part of the data is not changed in order to minimize the impact of this format change on existing processing equipment.

The two IR blocks are retransmitted as 10 bit words. The information content of these two blocks, each being different from the other, consists of:

a) Documentation to define the IR1 and IR2 parts.
b) IR1 or IR2 video.
c) End-of-Line-Code (EOLC).
d) Common Documentation.
e) Mode A IR Documentation.
f) Gridding Information.
g) Spare Words.

The structure of the IR block information field is shown diagrammatically in Figure 6.

All unused, unspecified or spare words will be assumed to be set to \$00. The use of the sign (\$) signifies hexadecimal notation. All unused , unspecified, or spare bits will be assumed to be set to zero.

IR DOC	IR VIDEO	EOLC	COMMON DOC.	GRIDDING	MODE A DOC	SPARE 384	FCS	UNUSED

Field Contents	10 Bit Words	Total Bits
IR DOC	16	160
IR VIDEO	3822	38220
EOLC	8	80
COM. DOC.	512	5120
GRIDDING	1024	10240
MODE A	128	1280
SPARE	384	3840
FCS		16
UNUSED	3586	35860

NOTE: In the Information Field of the IR Block the word length is 10 bits except for the Error Check sequence (FCS) which is 16 bits long.

FIGURE 6 - IR BLOCK INFORMATION FIELD

3.3.3.1 IR Documentation

The organization and description of the contents of the IR Documentation is given in Chart 2 and Table 2 below.

Although each IR Documentation word employs 10 bits, the two most significant bits (MSB's) are logic zero except for words 1, 2 and 16. The MSB of each word is transmitted first and referred to as bit 1 with the least significant bit (LSB) designated at bit 10. The use of the dollar sign ($) signifies hexadecimal notation.

3.3.3.2 IR Video

The IR video word employs all 10 bits with zero representing the minimum VAS signal and 1023 representing the maximum.

3.3.3.3 End of Line Code

The end of the line code (EOLC) is composed of eight 10-bit words containing all zeros.

NOTE: The VAS Image Processor (VIP) generates the IR documentation except where indicated.

CHART 2. IR DOCUMENTATION

GENERATED BY THE VIP EXCEPT WHERE NOTED

MSB 1	2	3	4	5	6	7	8	9	LSB 10

1	SECTOR CODE	
2		
3	SPARE	
4	FRAME CODE	
5	CHANGE CODE	
6	STEP CODE	
7	PREDICTED HEADER	
8	MSI CODE	
9	ADJUSTED EARTH COUNT	P/DU
10	ADJUSTED EARTH COUNT	P/DU
11	PHASE	
.		
.	SPARE	
.	.	
.	.	
.	.	
15	SPARE	
16	PARITY	P/DU

TABLE 2. MODE AAA IR DOCUMENTATION

WORD NUMBER	CONTENTS	DESCRIPTION
1,2	Sector Code	Identifies IR1 and IR2 from the VIP which is synonymous to the upper and lower detectors, respectively. For upper detectors word 1 = $14A and word 2 = $0AD, for lower detectors word 1 = $2B5 and word 2 = $352. This code permits the user to readily identify which detector outputs data on this line.
3	Spare	
4	Frame Code	$FE indicates picture transmission; $01 indicates out-of-frame.
5	Change Code	ONE ($FE) indicates start of picture if frame code is ONE ($FE) or end of picture if frame code is ZERO ($01).
6	Step Code	$FE indicates step; $01 indicates no-step (see p.33 Common Doc. Word 6)
7	Predicted Header	Bits 3 & 4 : Detector Size & Type 00 = Small Hg Cd Te 01 = Large Hg Cd Te 11 = In Sb Bit 5, Step Scan Flag 1 = Step Scan On Bit 6, Filter Wheel Accuracy 1 = $\theta \leq 2.5$ 0 = $\theta > 2.5$

TABLE 2. MODE AAA IR DOCUMENTATION (Cont.)

WORD NUMBER	CONTENTS	DESCRIPTION
		(LSB) Bit 7 - 10. Filter Wheel Position Same Coding as P2 (see word 5 common doc. - Section 1).
8	MSI Code	\$00 MSI Band A \$01 MSI Band B \$02 MSI Band C \$03 MSI Band D \$04 MSI Band E \$05 MSI Band F \$06 MSI Band G \$07 MSI Band H \$08 Dwell Sounding
9-10	Adjusted Earth Count	BCD earth count corrected for upper/lower detector offset.
11	Phase	See word 2 of common documentation.
12-15	Spare	
16	Parity	Odd parity - sum of bits in each column is odd for words 1-16. This word is the complement of the XOR of words 1-15.

3.3.3.4 Common Documentation

The Common Documentation follows the EOLC in each of the IR blocks as shown in Figure 6. The Common Documentation consists of four fields of 128 ten bit words each and contains general documentation information.

The FIRST field contains dynamic data such as: acquisition timing, ground system setup, frame start, scan count, spacecraft orbit parameters, etc. The SECOND field provides information on the satellite's configuration for a given frame. The types of data include: detector corrections, VAS instrument temperatures, and the frame's processor data load (PDL). The THIRD field contains temperature, visible, infrared, and detector geometry calibration data. The FOURTH field contains future data. Presently only future and next future orbit and attitude data is contained in the fourth field. The four fields of common documentation in the two IR blocks are identical. The order in which common documentation is output is the same as the associated VISIBLE video data.

The organization of the contents of the Common Documentation is depicted in Chart 3 and the contents described in Table 3.

Most of the common documentation data is generated by the VAS Image Processor (VIP). However, some of the common documentation is generated by the Processor/Distribution Unit (P/DU).

NOTE: In common documentation all data is coded in binary (e.g. one = 1 and zero = 0). Also note that the same data from VIS DOC, IR DOC, and MODE A DOC are coded as follows: one = 1111 1110 (FE) and zero = 0000 0001 (1). Also, SPARE or NOT USED bits and/or words are zeroed. If a non-zero is detected, this could indicate communications link or ground systems problems.

CHART 3. COMMON DOCUMENTATION (FIRST FIELD)

WORD	MSB 1	2	3	4	5	6	7	8	9	LSB 10
1			RETRACE							
2				PHASE						
3			S/C NAME							
4			FRAME CODE							
5			PREDICTED HEADER							
6			STEP CODE							
7			PDL LOCK CODE							
8			VAS HEADER STATUS							
9			CALIBRATION STATUS							
10			DIRECT TRANSMISSION MODE							
11			SECTOR COUNT MSB							
12			SECTOR COUNT LSB							
13			SPARE							
14			MM	BETA ANGLE (MSB's)						
15			BETA ANGLE							
16			BETA ANGLE (LSB's)							
17			BIT RATE LOOP ERROR							
18			PLL ERROR							
19			PLL ERROR							
20			SYNC WORD ERRORS (MSB's)							

CHART 3. (Cont.) COMMON DOCUMENTATION (FIRST FIELD)

WORD	MSB 1	2	3	4	5	6	7	8	9	LSB 10	
21			SYNC WORD ERRORS (LSB's)								
22			VIP ERRORS								
23			VIP ERRORS								
24			VIP ERRORS								
25			PE	SIGN	PREDICTED SCAN COUNT						
					THOU		HUN				
26			PREDICTED SCAN COUNT								
			TEN				ONE				
27			SPARE								
28			TIME-YEAR								
			TEN				ONE				
29			TIME - MSEC				TIME - DAY				
			ONE				HUN				
30			TIME - DAY								
			TEN				ONE				
31			TIME - HOUR								-SSD GMT
			TEN				ONE				
32			TIME - MINUTE								
			TEN				ONE				
33			TIME - SECOND								
			TEN				ONE				
34			TIME - MSEC								
			HUN				TEN				
35			0	0	0	0	IMAGE (4 MSB's)				
36			IMAGE (8 LSB's)								
37			VIP HRDWR ERRORS				BIT/FRAME SYNC				
			0	BTA	0	TAB	BFL	FRM	BIT	0	
38			SPARE							8/10	
39			EARTH COUNT (MSD (BCD))								
40			EARTH COUNT (LSD (BCD))								

CHART 3. (Cont.) COMMON DOCUMENTATION (FIRST FIELD)

WORD	MSB 1	2	3	4	5	6	7	8	9	LSB 10	
41			SCANNER DIRECTION								
42			SPARE								
43			SCANNER SELECT								
44			SYSTEM IDs P/DU ID#				VIP ID#				P/DU
45			CONTROLLING SYSTEM								
46			PLL STATUS TC6	TC5	TC4	TC3	TC2	ACQ	RAQ	0	
47			PLL STATE								
48			VARIABLE FRAME START 0				4 MSBs				
49			VARIABLE FRAME START 8 LSBs								
50			VARIABLE FRAME END 0				4 MSBs				
51			VARIABLE FRAME END 8 LSBs								
52			SPARE								
53			SPARE								
54			IR1 RIGHT HORIZON (MSB's)								
55			IR1 RIGHT HORIZON (LSB's)								
56			IR1 LEFT HORIZON (MSB's)								
57			IR1 LEFT HORIZON (LSB's)								
58			IR2 RIGHT HORIZON (MSB's)								
59			IR2 RIGHT HORIZON (LSB's)								
60			IR2 LEFT HORIZON (MSB's)								

CHART 3. (Cont.) COMMON DOCUMENTATION (FIRST FIELD)

WORD	MSB 1	2	3	4	5	6	7	8	9	LSB 10	
61			IR2 LEFT HORIZON (LSB's)								
62			SPARE								
63			SPARE								
64			0	PLL CYCLE TIME							
65			PLL CYCLE TIME								
66			PLL CYCLE TIME								
67			SPARE								
68			SPARE								
69			0	0	0	CALI	RAW SCAN COUNT (4 MSB)				
70			RAW SCAN COUNT (8 LSB)								
71			EQUAT SCAN COUNT (BCD FORMAT)								
72			EQUAT SCAN COUNT(BCD FORMAT)								
73			P/DU HARDWARE ERRORS								P/DU
74			P/DU ERRORS								P/DU
75			P/DU ERRORS								P/DU
76			P/DU ERRORS								P/DU
77			P/DU ERRORS								P/DU
78			SPARE								
79			SPARE								
80			SPARE								

CHART 3. (Cont.) COMMON DOCUMENTATION (FIRST FIELD)

WORD	MSB 1	2	3	4	5	6	7	8	9	LSB 10
81	NUMBER OF HEADER ERRORS									
82	NUMBER OF HEADER SYNC ERRORS									
83	NUMBER OF SCAN INCREMENT ERRORS									
84			O/A DATA CHANGE IN PROGRESS							
85			TIME-YEAR							
			TEN				ONE			
86			TIME-MSEC				TIME-DAY			
			ONE				HUN			
87			TIME-DAY							
			TEN				ONE			
88			TIME-HOUR							
			TEN				ONE			
89			TIME-MINUTE							
			TEN				ONE			
90			TIME-SECOND							
			TEN				ONE			
91			TIME-MSEC							
			HUN				TEN			
92			TIME-YEAR							
			TEN				ONE			
93			TIME-MSEC				TIME-DAY			
			ONE				HUN			
94			TIME-DAY							
			TEN				ONE			
95			TIME-HOUR							
			TEN				ONE			
96			TIME-MINUTE							
			TEN				ONE			
97			TIME-SECOND							
			TEN				ONE			
98			TIME-MSEC							
			HUN				TEN			
99			ORBIT & ATTITUDE BLOCK NUMBER							
100			O&A MINOR FRAME INDEX							

CHART 3. (Cont.) COMMON DOCUMENTATION (FIRST FIELD)

WORD	MSB 1	2	3	4	5	6	7	8	9	LSB 10
101			ORBIT & ATTITUDE							
102			WORD 1 (MFI = 1)							
103			OR WORD 7 (MFI = 2)							
104										
105			ORBIT & ATTITUDE							
106			WORD 2 (MFI = 1)							
107			OR WORD 8 (MFI = 2)							
108										
109			ORBIT & ATTITUDE							
110			WORD 3 (MFI = 1)							
111			OR WORD 9 (MFI = 2)							
112										
113			ORBIT & ATTITUDE							
114			WORD 4 (MFI = 1)							
115			OR WORD 10 (MFI = 2)							
116										
117			ORBIT & ATTITUDE							
118			WORD 5 (MFI = 1)							
119			OR WORD 11 (MFI = 2)							
120										

CHART 3. (Cont.) COMMON DOCUMENTATION (FIRST FIELD)

WORD	MSB 1	2	3	4	5	6	7	8	9	LSB 10	
121			ORBIT & ATTITUDE								
122			WORD 6 (MFI = 1)								
123			OR WORD 12 (MFI = 2)								
124											
125									O & A SORC	GRID VALD	P/DU
126			VIP SOFTWARE VERSION								
127			P/DU SOFTWARE VERSION								P/DU
'8	LONGITUDINAL PARITY										P/DU

TABLE 3. COMMON DOCUMENTATION DESCRIPTION (FIRST FIELD)

WORD NUMBER	CONTENTS	DESCRIPTION
1	Retrace	ONE ($FE) indicates scanner moving at a rate of 10 2/3 increments/spin
2	Phase	Bit 3 SPARE Bit 4 1 = Calibration data being processed Bit 5 1 = Initial verify mode Bit 6 1 = Initial verify temperatures have been determined Bit 7 1 = IR data for this scan was calibrated Bit 8 1 = Final verify mode Bit 9 1 = Final verify temperatures have been determined Bit 10 SPARE
3	Spacecraft Name	Bits 3-10 S/C BCD Number (e.g. SMS1=01, SMS2=02, GOES1=03, GOES2=04...,GOES8=10,etc.)
4	Frame Code	ONE ($FE) = VIP is processing video data for the picture
5	Predicted Header	In VISSR mode $80, Otherwise : Bits 3-4 Detector Size and Type 00 - Small Hg Cd Te 01 - Large Hg Cd Te 11 - In Sb

TABLE 3. (Cont.) COMMON DOCUMENTATION DESCRIPTION (FIRST FIELD)

WORD NUMBER	CONTENTS		DESCRIPTION
		Bits 5	Step Scan Flag 1 = Step Scan On 0 = Step Scan Off
		Bits 6	Filter Wheel Position Accuracy 1 = ($\theta \leq 2.5°$) 0 = ($\theta > 2.5°$)
		Bits 7-10	Filter Wheel Position 0000=Spectral Band 1 1011=Spectral Band 2 0100=Spectral Band 3 0010=Spectral Band 4 1010=Spectral Band 5 0110=Spectral Band 6 0101=Spectral Band 7 1000=Spectral Band 8 0001=Spectral Band 9 0111=Spectral Band 10 0011=Spectral Band 11 1001=Spectral Band 12
6	Step Code		In VISSR Mode: ZERO ($01) indicates this is not to be used to expose film, and fascimile recorder line is not to be incremented (stepped). ONE ($FE) indicates a normal line transmission. In VAS Mode: ONE ($FE) indicates sucessful completion of check procedure.

TABLE 3. (Cont.) COMMON DOCUMENTATION (FIRST FIELD)

WORD NUMBER	CONTENTS	DESCRIPTION
7	PDL Lock Code	Bit 10 1 = VIP is synchronized with the execution of the current PDL. 0 = VIP PDL is not in Sync
8	VAS Header Status	Bit 3 = 1 IR agrees with predicted header Bit 4 = 1 Eight IR sync bits found (VAS mode only) Bit 9-10 Channels used for header verification (01:IR1; 10:IR2; 11 both)
9	Calibration Status	Bits 7-8 00: 1 to 1 VIS Calibration 01: Normal VIS w/Dither 10: Normal VIS wo/Dither Bit 10 1: Normal IR Calibration 0: 1 to 1 IR Calibration
10	Direct Transmission Mode	ONE ($FE) indicates 28 MBP's; ZERO ($01) indicates 14 MBP's.
11-12	Sector Count	The sector count is a sequential number modulo 65536. The count is incremented for each IR1 output starting with 0 for the first IR1 output after the VIP enters the OPERATE mode. The second output (IR1) will have number 1. This number is intended to permit the mode AAA receive equipment to detect gaps in the data.

TABLE 3. (Cont.) COMMON DOCUMENTATION (FIRST FIELD)

WORD NUMBER	CONTENTS	DESCRIPTION
13	SPARE	
14-16	Beta Angle (Binary)	Word 14 Bit 3=1 Midnight mode (315°- 45°) Bits 4-10 7 MSB's Word 15 Bits 3-10 8 Mid Word 16 Bits 3-10 8 LSB's
17	Bit Rate Loop Error	Range: $-24 \leq N \leq 24$ with negative numbers in two's compliment form.
18-19	PLL Error (Signed 2's complement coded)	Difference between Digital Sun Count and the Local Sun Count in 3.5 MHz clock periods. Invalid when PLL is in the phase state--see Word 47. Word 18 Bit 3-10 (8 MSB's) Word 19 Bit 3-10 (8 LSB's)
20-21	Sync Word Errors (Count)	Word 20 Bits 3-10 (8 MSB's) Word 21 Bits 3-10 (8 LSB's)
22-24	VIP Errors	Word 22 Bit 1 = 1 Invalid Data Type Bit 2 = 1 Invalid Bit Map Bit 3 = 1 Invalid Data Subtype Bit 4 = 1 Invalid VIP Mode for Command Bit 5 = 1 Invalid S/C ID for Command Bit 6 = 1 Invalid Source for Command Bit 7 = 1 Current O & A Data in Error Bit 8 = 1 Detector Geometry in Error

TABLE 3. (Cont.) COMMON DOCUMENTATION (FIRST FIELD)

WORD NUMBER	CONTENTS	DESCRIPTION
		Bit 9 = 1 IR Calibration in Error Bit 10= 1 Next O & A Data in Error Word 23 Bit 1 = 1 PCM Data in Error Bit 2 = 1 PDL Data in Error Bit 3 = 1 Visible Cal. Data in Error Bit 4 = 1 Invalid Picture Control Command Bit 5 = 1 Invalid PLL Control Command Bit 6 = 1 Invalid VIP Control Command Bit 7 = 1 Invalid HW Config. Command Bit 8 = 1 Invalid S/C Config. Command Bit 9 = 1 Invalid VIP Config. Command Bit 10 Spare Word 24 -- Unused
25-26	Predicted Scan Count	BCD mirror position. 1 = Normal North Limit. 1821 = Normal South Limit. BCD value split into 2 characters/word Word 25 Bit 3 1 = Word Zero Parity Error Bit 4 0 = Positive Scan Count 1 = Negative Scan Count Bits 5-10 2 most significant BCD characters Word 26 Bits 3-10 2 least significant BCD characters
27	SPARE	
28-34	SSD GMT	BCD Scan Sync Detect Time Word 28 Year - 2 LSD Word 29 (Bits 3-6) Milliseconds(Ones)(LSD) (Bits 7- 10) Day of Year (MSD) Word 30 Day of Year cont.: Two (LSD)s

TABLE 3. (Cont.) COMMON DOCUMENTATION (FIRST FIELD)

WORD NUMBER	CONTENTS	DESCRIPTION
		Word 31 Hour Word 32 Minute Word 33 Second Word 34 Millisecond (Hundreds--Tens)
35-36	Image Count	The number of lines in the image for which the step code has been a one. Word 35 Bit 3-6 Spare Word 35 Bit 7-10 Image (4 MSB's) Word 36 Bit 3-10 Image (8 LSB's)
37	VIP Hardware Errors	Bit 3 NOT USED Bit 4 1 = Beta Error--Bad O/A Data or bad VDM pointing angle Bit 5 NOT USED Bit 6 1 = Table Lookup Error Detected visible lookup table parity error. Bit 7 1 = Large bit rate loop error Bit 8 1 = Frame Sync in Lock Bit 9 1 = Bit Sync in Lock Bit 10 NOT USED
38	IR Data Input Bit Mode	Bit 10 1 = 8 bit 0 = 10 bit
39-40	Earth Count	BCD Scan Count adjusted such that the center of the earth will be 836.
41	Scanner Direction	ONE ($FE) = North to South Frame ZERO ($01) = South to North Frame

TABLE 3. (Cont.) COMMON DOCUMENTATION (FIRST FIELD)

WORD NUMBER	CONTENTS	DESCRIPTION
42	SPARE	
43	Scanner Select	0 = Redundant encoder/lamp 1 1 = Primary encoder/lamp 1 2 = Redundant encoder/lamp 2 3 = Primary encoder/lamp 2
44	System IDs	Bits 3-6 P/DU ID # (00 unused) Bits 7-10 VIP ID #
45	Controlling System	The System Controlling the VIP's operation. 0 = NONE 1 = GMACS 2 = M & T
46	Phase Lock Loop Status	Bit 3 1 = Time Constant 6 Bit 4 1 = Time Constant 5 Bit 5 1 = Time Constant 4 Bit 6 1 = Time Constant 3 Bit 7 1 = Time Constant 2 Bit 8 1 = Acquistion Bit 9 1 = Reacquistion Bit 10 NOT USED
47	Phase Lock Loop State	Bit 3 1 = Phase Bit 4 1 = Acquistion Bit 5 1 = Track Bit 6 1 = Coast Bits 7-10 NOT USED

TABLE 3. (Cont.) COMMON DOCUMENTATION (FIRST FIELD)

WORD NUMBER	CONTENTS	DESCRIPTION
48-49	Variable Frame Start	In Units of Predicted Scan Count First word (4MSB's); Second word (8 LSB's). NOTE: Used in VISSR Variable Scan Mode only.
50-51	Variable Frame End	Same as 48-49.
52-53	Spare	
54-55	IR1 East Horizon Point	Horizon point in terms of IR samples 1 to 3822 Word 54 (8 MSB's) Word 55 (8 LSB's) If no detected horizon: Word 54 = OF Word 55 = FF
56-57	IR1 West Horizon Point	Horizon point in terms of IR samples, 1 to 3822. Word 56 (8 MSB's) Word 57 (8 LSB's) If no horizon detected: Word 56 = OF Word 57 = FF
58-59	IR2 East Horizon Point	Horizon point in terms of IR samples, 1 to 3822. Word 58 (8 MSB's) Word 59 (8 LSB's) If no horizon detected: Word 58 = OF Word 59 = FF

TABLE 3. (Cont.) COMMON DOCUMENTATION (FIRST FIELD)

WORD NUMBER	CONTENTS	DESCRIPTION
60-61	IR2 West Horizon Point	Horizon point in terms of IR samples, 1 to 3822. Word 60 (8 MSB's) Word 61 (8 LSB's) If no horizon detected: WORD 60 = 0F WORD 61 = FF
62-63	SPARES	
64-66	PLL Cycle Time	Phase lock loop cycle time representing the spin period in 0.1 microsecond resolution. Word 64 Bits 4-10 (7 MSB's) Word 65 Bits 3-10 (8 MID Bits) Word 66 Bits 3-10 (8 LSB's)
67-68	SPARES	
69-70	Raw Scan Count	Word 69 Bits 3-5 Not Used Word 69 Bit 6 1=Calibration or IR Verify Word 69 Bits 7-10 Raw Scan Count (4 MSB's) Word 70 Bits 3-10 Raw Scan Count (8 LSB's)
71-72	Equatorial Scan Count	BCD scan count corresponding to the equator (1 to 1821 numbering system). Used in processor-off mode to determine frame limits.

TABLE 3. (Cont.) COMMON DOCUMENTATION (FIRST FIELD)

WORD NUMBER	CONTENTS	DESCRIPTION
73	P/DU Hardware Errors	Reserved
74-77	P/DU Detected System Errors	Word 74 Bit 3=1 Unexpected Satellite ID Bit 4=1 Unexpected VAS/VISSR Mode Bit 5=1 VIP PDL does not agree with GMACS Bit 6=1 VISSR Frame Definition Inconsistent Bit 8=1 No Grid Data Base 1 (Primary) Bit 9=1 No Grid Data Base 2 (Secondary) Bit10=1 No Current O & A Data Set Word 75 Bit 3=1 No Next O & A Data Set Bit 4=1 No Future O & A Data Set Word 76 Bit 3=1 VIP PDL Change Bit 4=1 Inconsistent VIP O & A Data Bit 5=1 Unexpected VIP Satellite ID Bit 6=1 Gap in VIP Data (Sector Count Jump) Bit 7=1 Unexpected Scan Count Bit 8=1 Unexpected Earth Count Bit 9=1 Unexpected VAS Mode Bit10=1 Unexpected VAS Submode Word 77 Bit 3=1 Inconsistent MSI/DS Band Number Bit 4=1 Inconsistent Spectral Band Number Bit 5=1 Inconsistent FOV Size
78-80	SPARES	
81	Number of S/C Header Errors	Accumulation of detected header errors after frame start.

TABLE 3. (Cont.) COMMON DOCUMENTATION (FIRST FIELD)

WORD NUMBER	CONTENTS	DESCRIPTION
82	Number of Header Sync Errors	Accumulation of detected header sync errors after frame start.
83	Number of Scan Increment Errors	Accumulation of scan increment errors detected after frame start.
84	O/A Data Change In Progress	Bit 10 1=Data Change. Occurs between frames for only one spin. 0=No Data Change.
85-91	Time	Beginning date of valid O&A data
92-98	Time	Ending date of valid O&A data
99-124	Orbit and Attitude Data	See Table 3A; the block number remains fixed for two spins during which the minor frame index (MFI) takes on successive values 1 and 2; the block number then increments.
125	O&A Source/ Grid Validity (Bits 3-8 Spare)	Source Bit 9 = 1 GMACS = 0 VIP Grids Bit 10 = 1 Valid Grids = 0 No Grids
126	VIP Software Version	Current software revision in use (binary).
127	P/DU Software Version	Current software revision in use. (binary).
128	Longitudinal Parity	Complement of "Exclusive OR" of first 127 words.

TABLE 3A. ORBIT AND ATTITUDE DOCUMENTATION

Documentation Words		O&A Word Number										
99		Block Number*	$01	$02	$03	$04	$05	$06	$07	$08	$09	$0A
100		Minor Frame Index	**	**	**	**	**	**	**	**	**	**
101 - 104		1	DATE1	SPER	EST	CBO	CXO	CYO	CZO	EPH	SBSCANB	-
105 - 108		2	TIME1	SPRA1	EET	CB1	CX1	CY1	CZ1	SMA	SBSAMB	SPRA2
109 - 112	MFI $01	3	-	SPDC1	FPER	CB2	CX2	CY2	CZ2	ECC	SBLATB	SPDC2
113 - 116		4	-	ZETA	TC	CB3	CX3	CY3	CZ3	INC	SBLONGB	DELTAL
117 - 120		5	-	RHO	CEO	CB4	CX4	CY4	CZ4	MA	YAWB	DELTAS
121 - 124		6	-	ETA	CE1	CB5	CX5	CY5	CZ5	AP	-	-
101 - 104		7	X1	GAMMA	CE2	CB6	CX6	CY6	CZ6	RAN	X2	-
105 - 108		8	Y1	NAMES	CE3	CB7	CX7	CY7	CZ7	SBSCAN	Y2	-
109 - 112	MFI $02	9	Z1	ID	CRO	CB8	CX8	CY8	CZ8	SBSAMP	Z2	-
113 - 116		10	VX1	SRA1	CR1	CB9	CX9	CY9	CZ9	SBLAT	VX2	SRA2
117 - 120		11	VY1	SDC1	CR2	PNL	CX10	CY10	CZ10	SBLONG	VY2	SDC2
121 - 124		12	VZ1	GRA1	CR3	RNL	-	-	EPY	YAW	VZ2	GRA2

* Block number = Minor frame index = $00 if O&A data not present; $ implies hexadecimal notation.

**Minor Frame Index = $01 if O&A Word Number is less than 7; MFI = $02 otherwise

TABLE 3A. (Cont.) ORBIT AND ATTITUDE DOCUMENTATION

Name	Unit*	Description
DATE1	$YYDDD_{10}$ in binary	Date for TIME1; DATE1 $\leq$ 99366
TIME1	Seconds * 100	Epoch (GMT); TIME1 < 864×10^4
TIME2	Seconds * 100	Not documented; TIME1 + 468×10^4
XN YN ZN	km * 2^{13}	Satellite position at TIMEN in inertial coordinate system of date; N = 1 or 2
VXN VYN VZN	(km/hour) * 2^{13}	Satellite velocity at TIMEN
SPER	usec	Satellite spin period with respect to the earth at epoch (microseconds)
SPRAN	degrees * 2^{21}	Spin axis right ascenion at TIMEN
SPDCN	degrees * 2^{21}	Spin axis declination at TIMEN
ZETA	degrees * 2^{21}	VISSR alignment coordinates;

*All data is shown as an integer generated by multiplication by a factor to preserve the required resolution. For example, the quantity ZETA in degrees was multiplied by 2^{21} and the integer part of the product is shown in the O&A documentation. Thus the angle 10.001 degrees is represented as 20973617.

TABLE 3A. (Cont.) ORBIT AND ATTITUDE DOCUMENTATION

Name	Unit*	Description
RHO ETA GAMMA		ZETA = line bias, RHO = element bias, ETA = skew bias and GAMMA = sun pulse to VISSR angle.
NAMES	codes	Most significant byte (8 bits) contains source of O&A data: 0 = M&T, 1 = VIRGS/GMACS; next byte contains S/C name 1 = SMS-1, 2 = SMS 2, 8 = GOES-6; least significant 16 bits contain the serial number of the O&A data.
ID	coded	Code to specify method used for O&A determination
SRAN	degrees * 2^{21}	Sun right ascension at TIMEN
SDCN	degrees * 2^{21}	Sun declination at TIMEN
GRAN	degrees * 2^{21}	Greenwich right ascension at TIMEN
EST	seconds * 100	Eclipse start time on DATE1
EET	seconds * 100	Eclipse end time on DATE1
FPER	microsecond	Satellite spin period with respect to sun at epoch plus 6.5 hours (neglecting eclipse effects).

TABLE 3A. (Cont.) ORBIT AND ATTITUDE DOCUMENTATION

Name	Unit*	Description
TC	seconds	Eclipse thermal time constant
CEI	scan steps	Chebyshev equat parameters; I = 0, ..., 3 represents S/DB scan count at which earth disk center is scanned.
CRI	msec * 100	Chebyshev retransmission parameters; I = 0, ..., 3 represents time for signal to propagate from DCA station to satellite
CBI	degrees * 273 * 2^{11}	Chebyshev Beta parameters; I = 0, ..., 9
	$(273 \times 2^{11} = \frac{629920}{360} * 2^5)$	
PNL	integer	Primary scanner north limit
RNL	integer	Redundant scanner north limit
CX1	km * 2^{13}	Chebyshev position parameters; I = 0, ..., 10
CY1		
CZ1		
EPY	YYMMDD (year, month, day)	Epoch time for keplerian elements
EPH	HHMMSS (hour, minute, second)	Binary

TABLE 3A. (Cont.) ORBIT AND ATTITUDE DOCUMENTATION

Name	Unit*	Description	
SMA	km * 100	semi-major axis	
ECC	unit less * 1000000	Eccentricity	
INC	Degree * 1000	Inclimation	
MA	Degree * 1000	Mean Anomoly	
AP	Degree * 1000	Argument of Perigee	
RAN	Degree * 1000	Right Ascension of Ascending Node	
SBSCAN	IR Scan Line * 100	Subpoint scan number	P/DU
SBSAMP	IR Sample * 100	Subpoint sample number	P/DU
SBLAT	DEG * 100	Subpoint latitude	P/DU
SBLOG	DEG * 100	Subpoint longitude	P/DU
YAW	DEG * 1000	Yaw angle	P/DU
SBSCANB	IR Scan Line * 100	SBSCAN reformatted in BCD	P/DU
SBSAMPB	IR Sample * 100	SBSAMP reformatted in BCD	P/DU
SBLATB	DEG * 100	SBLAT reformatted in BCD	P/DU
SBLONGB	DEG * 100	SBLONG reformatted in BCD	P/DU
YAWB	DEG * 1000	YAW reformatted in BCD	P/DU
DELTA L	INTEGER	$\pm$ North/South Line Shift (offset)	|
DELTA S	INTEGER	$\pm$ East/West Pixel Shift (offset)	|

NOTE: The keplerian elements described above are generated by the NOAA "VISSR Image Registration and Gridding System" (VIRGS) and are documented here for use by similar systems.

CHART 4. COMMON DOCUMENTATION (SECOND FIELD)

Word	MSB 1	2	3	4	5	6	7	8	9	LSB 10
1			SPARE							
2			SPARE							
3			SPARE							
4			SPARE							
5			SPARE							
6			SPARE							
7			VISIBLE DETECTOR PATCH STATUS							
8			VISIBLE DETECTOR PATCH STATUS							
9	IR1 INTEGER SENSOR SPACING									
10	IR1 REMAINDER SENSOR SPACING									
11	IR2 INTEGER SENSOR SPACING									
12	IR2 REMAINDER SENSOR SPACING									
13			RETRANSMISSION DELAY							
14			RETRANSMISSION DELAY							
15			RETRANSMISSION DELAY							
16			SPARE							
17			SPARE							
18			SPARE							
19			SPARE							
20			ACTUAL RECEIVED IR1 HEADER							

CHART 4. (Cont.) COMMON DOCUMENTATION (SECOND FIELD)

<table>
<tr><th>Word</th><th>MSB
1</th><th>2</th><th>3</th><th>4</th><th>5</th><th>6</th><th>7</th><th>8</th><th>9</th><th>LSB
10</th></tr>
<tr><td>21</td><td></td><td></td><td colspan="8">ACTUAL RECEIVED IR2 HEADER</td></tr>
<tr><td>22</td><td></td><td></td><td colspan="8">WIDEBAND VERIFY STATUS</td></tr>
<tr><td>23</td><td></td><td></td><td colspan="8">SUBMODE 1, 2, 3 0 = MSI</td></tr>
<tr><td>24</td><td></td><td></td><td colspan="4"></td><td colspan="2">SCAN
MODE</td><td>VAS
MODE</td><td>MSI
DS</td></tr>
<tr><td>25</td><td></td><td></td><td colspan="4">MSI BAND A</td><td colspan="4">MSI BAND B</td></tr>
<tr><td>26</td><td></td><td></td><td colspan="4">MSI BAND C</td><td colspan="4">MSI BAND D</td></tr>
<tr><td>27</td><td></td><td></td><td colspan="4">MSI BAND E</td><td colspan="4">MSI BAND F</td></tr>
<tr><td>28</td><td></td><td></td><td colspan="4">MSI BAND G</td><td colspan="4">MSI BAND H</td></tr>
<tr><td rowspan="2">29</td><td rowspan="2"></td><td rowspan="2"></td><td rowspan="2">0</td><td rowspan="2">0</td><td rowspan="2">0</td><td rowspan="2">0</td><td rowspan="2">0</td><td rowspan="2">0</td><td colspan="2">MSI</td></tr>
<tr><td>IGFOV</td><td>SIZE</td></tr>
<tr><td>30</td><td></td><td></td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td colspan="3">DS MODE 1
NO. STEPS</td></tr>
<tr><td>31</td><td></td><td></td><td colspan="8">DS BAND 1 #SPINS</td></tr>
<tr><td>32</td><td></td><td></td><td colspan="8">DS BAND 2 #SPINS</td></tr>
<tr><td>33</td><td></td><td></td><td colspan="8">DS BAND 3 #SPINS</td></tr>
<tr><td>34</td><td></td><td></td><td colspan="8">DS BAND 4 #SPINS</td></tr>
<tr><td>35</td><td></td><td></td><td colspan="8">DS BAND 5 #SPINS</td></tr>
<tr><td>36</td><td></td><td></td><td colspan="8">DS BAND 6 #SPINS</td></tr>
<tr><td>37</td><td></td><td></td><td colspan="8">DS BAND 7 #SPINS</td></tr>
<tr><td>38</td><td></td><td></td><td colspan="8">DS BAND 8 #SPINS</td></tr>
<tr><td>39</td><td></td><td></td><td colspan="8">DS BAND 9 #SPINS</td></tr>
<tr><td>40</td><td></td><td></td><td colspan="8">DS BAND 10 #SPINS</td></tr>
</table>

CHART 4. (Cont.) COMMON DOCUMENTATION (SECOND FIELD)

Word	MSB 1	2	3	4	5	6	7	8	9	LSB 10
41			DS BAND 11 #SPINS							
42			DS BAND 12 #SPINS							
43			0	0	0	0	0	DS MODE 3 NO. STEPS		
44			DS MODE 2 DET SIZE							
			3	4	5	1	7	8	9	10
45			0	0	0	0	0	PWR	DIR	CAL
46			0	0	0	0	START LINE			
47			START LINE							
48			0	0	0	0	END LINE			
49			END LINE							
50			0	0	0	0	0	0	0	MUL
51			PDL ID NUMBER							
52			PDL ID NUMBER				0	0	0	0
53			IR CHANNELS GAIN STATE							
54		SECONDARY MIRROR								
55		PRIME MIRROR								
56		PRIME MIRROR APERTURE STOP								
57		SECONDARY MIRROR SHIELD								
58		BLACKBODY NUMBER 1								
59		BLACKBODY NUMBER 2								
60		SCAN MIRROR								

CHART 4. (Cont.) COMMON DOCUMENTATION (SECOND FIELD)

Word	MSB 1	2	3	4	5	6	7	8	9	LSB 10
61		BAFFLE TUBE FORWARD END								
62		BAFFLE TUBE AFT END								
63		SHUTTER CAVITY								
64		T15 AUX POWER SUPPLY VOLTAGE								
65		FILTER WHEEL								
66			VAS-TEMP DATA SOURCE							
67			SPARE							
68			SPIN NUMBER							
69			SPARE							
70			SPARE							
71			SPARE							
72			SPARE							
73			SPARE							
99			SPARE							
100			CALIBRATION VALID TIME INTERVAL							
113			CALIBRATION VALID TIME INTERVAL							
114			VISIBLE NORMALIZATION TIME INTERVAL							
115			VISIBLE NORMALIZATION TIME INTERVAL							

CHART 4. (Cont.) COMMON DOCUMENTATION (SECOND FIELD)

Word	MSB 1	2	3	4	5	6	7	8	9	LSB 10	
116			VISIBLE NORMALIZATION TIME INTERVAL								
.			.								
.			.								
.			.								
127			VISIBLE NORMALIZATION TIME INTERVAL								
128	LONGITUDINAL PARITY										P/DU

TABLE 4. COMMON DOCUMENTATION

WORD NUMBER	CONTENTS	DESCRIPTION
1-6	Spares	
7	Visible Patch Data Mask	Bits 3-9 Used; Bit 10: Spare 0 = Disregard Word 8 Data 1 = Use Word 8 Patch Data
8	Visible Patch Data (Bit 10: Unused)	Bit 3 = 0 VIS 1 inserted for VIS 2 = 1 VIS 2 inserted for VIS 1 Bit 4 = 0 VIS 2 inserted for VIS 3 = 1 VIS 3 inserted for VIS 2 Bit 5 = 0 VIS 3 inserted for VIS 4 = 1 VIS 4 inserted for VIS 3 Bit 6 = 0 VIS 4 inserted for VIS 5 = 1 VIS 5 inserted for VIS 4 Bit 7 = 0 VIS 5 inserted for VIS 6 = 1 VIS 6 inserted for VIS 5 Bit 8 = 0 VIS 6 inserted for VIS 7 = 1 VIS 7 inserted for VIS 6 Bit 9 = 0 VIS 7 inserted for VIS 8 = 1 VIS 8 inserted for VIS 7
9	IR1 Integer Sensor Spacing	Multiples of 84 Beta Units--i.e. sample spacing (Bits 1-10 used).
10	IR1 Remainder Sensor Spacing	Remainder in Beta Units of sample spacing (Bits 1-10 used).
11	IR2 Integer Sensor Spacing	Same as Word 9
12	IR2 Remainder Sensor Spacing	Same as Word 10

TABLE 4. (Cont.) COMMON DOCUMENTATION (SECOND FIELD)

WORD NUMBER	CONTENTS	DESCRIPTION
13-15	Retransmission Delay	Word 13 Bits 7-10 (4 MSB's) Word 14 Bits 3-10 (8 MID Bits) Word 15 Bits 3-10 (8 LSB's)
16-19	Spares	
20	S/C Header	Raw IR1 Header Received
21	S/C Header	Raw IR2 Header Received
22	Wideband Verify Status (Initial Verify, IV) (Final Verify, FV)	Bits 3-4 Spare Bit 5 1 = PDL extracted during IV and FV from wideband data. Bit 6 1 = Data Present Bit 7 1 = Sync Bit Error, i.e., 184 sync bits not found. (Data valid only if data present = 1). Bit 8 1 = Data Bit Error, i.e., 184 program bits do not agree with command (data valid only if data present = 1).
23	Submode	1, 2, or 3 for DS, 0 for MSI, 4 for calibration
24	Mode	Bits 3-6 Spare Bits 7-8 VISSR mode 00 Unused 01 VISSR Normal Scan 10 VISSR Variable Scan 11 VISSR Single Scan

TABLE 4. (Cont.) COMMON DOCUMENATION (SECOND FIELD)

WORD NUMBER	CONTENTS	DESCRIPTION	
		Bit 9	1 = VAS Mode
			0 = VISSR Mode
		Bit 10	VAS Mode
			1 = MSI
			0 = DS
25	MSI Band A and B	Bits 3-6	Band A
		Bits 7-10	Band B
26	MSI Band C and D	Bits 3-6	Band C
		Bits 7-10	Band D
27	MSI Band E and F	Bits 3-6	Band E
		Bits 7-10	Band F
28	MSI Band G and H	Bits 3-6	Band G
		Bits 7-10	Band H
29	*MSI Band IGFOV Size	Bits 3-8	Not Used
		Bit 9	0 = IGFOV applies to spins A, C, E, & G.
			1 = IGFOV applies to Band 8 for any spin.
		Bit 10	1 = Large; 0 = Small
30	DS Sub-mode #1	Number of Steps	
		Bits 3-7	Not Used
		Bits 8-10	000=1 step; 111=8 steps
31	DS Sub-mode #2 Spectral Band 1	Number of Dwell Spins	
		Bits 3-10	00000000 = Skip Band
			11111111 = 255 Spins

* Changes for GOES H.

TABLE 4. (Cont.) COMMON DOCUMENTATION (SECOND FIELD)

WORD NUMBER	CONTENTS	DESCRIPTION
32	DS Sub-mode #2 Spectral Band 2	Number of Dwell Spins Bits 3-10 00000000 = Skip Band 11111111 = 255 Spins
33	DS Sub-mode #2 Spectral Band 3	Number of Dwell Spins Bits 3-10 00000000 = Skip Band 11111111 = 255 Spins
34	DS Sub-mode #2 Spectral Band 4	Number of Dwell Spins Bits 3-10 00000000 = Skip Band 11111111 = 255 Spins
35	DS Sub-mode #2 Spectral Band 5	Number of Dwell Spins Bits 3-10 00000000 = Skip Band 11111111 = 255 Spins
36	DS Sub-mode #2 Spectral Band 6	Number of Dwell Spins Bits 3-10 00000000 = Skip Band 11111111 = 255 Spins
37	DS Sub-mode #2 Spectral Band 7	Number of Dwell Spins Bits 3-10 00000000 = Skip Band 11111111 = 255 Spins
38	DS Sub-mode #2 Spectral Band 8	Number of Dwell Spins Bits 3-10 00000000 = Skip Band 11111111 = 255 Spins
39	DS Sub-mode #2 Spectral Band 9	Number of Dwell Spins Bits 3-10 00000000 = Skip Band 11111111 = 255 Spins

TABLE 4. (Cont.) COMMON DOCUMENTATION (SECOND FIELD)

WORD NUMBER	CONTENTS	DESCRIPTION
40	DS Sub-mode #2 Spectral Band 10	Number of Dwell Spins Bits 3-10 00000000 = Skip Band 11111111 = 255 Spins
41	DS Sub-mode #2 Spectral Band 11	Number of Dwell Spins Bits 3-10 00000000 = Skip Band 11111111 = 255 Spins
42	DS Sub-mode #2 Spectral Band 12	Number of Dwell Spins Bits 3-10 00000000 = Skip Band 11111111 = 255 Spins
43	DS Sub-mode #3	Number of Steps Bits 3-7 Not Used Bits 8-10 000 = 1 step 111 = 8 steps
44	DS Sub-mode #2	Detector Size 0 = Small; 1 = Large Bit 3 Band #3 IGFOV size Bit 4 Band #4 IGFOV size Bit 5 Band #5 IGFOV size Bit 6 Band #6 IGFOV size (Always=1) Bit 7 Band #7 IGFOV size Bit 8 Band #8 IGFOV size Bit 9 Band #9 IGFOV size Bit 10 Band #10 IGFOV size
45	Logic Signals	DS Visible Channel PMT Power ON/OFF (DS sub-mode #2) Bit 8 0 = ON 1 = OFF Frame Scan Direction North-South (N-S) Bit 9 0 = N-S 1 = S-N

TABLE 4. (Cont.) COMMON DOCUMENTATION (SECOND FIELD)

WORD NUMBER	CONTENTS	DESCRIPTION
		Electronics Calibration ON/OFF Bit 10 0 = OFF 1 = ON Bits 3-7 Not Used
46-47	Frame Start Line Number (RSC + 2048)	Word 46 Bits 3-6 Spare Word 46 Bits 7-10 4 MSB's Word 47 Bits 3-10 8 LSB's
48-49	Frame End Line Number (RSC + 2048)	Word 48 Bits 3-6 Spare Word 48 Bits 7-10 4 MSB's Word 49 Bits 3-10 8 LSB's
50	DS Multiplex Mode	Bits 3-9 Spare Bits 10 1 = ON; 0 = OFF
51-52	Processor Data Load (PDL) Number expressed as binary count	Word 51 Bits 3-10 8 MSB's Word 52 Bits 3-6 4 LSB's Word 52 Bits 7-10 Spare
53	IR Channel Gain State	0 = 6.8dB 1 = 0 dB
54	Secondary Mirror	Temperature (T1) in Raw Counts
55	Primary Mirror	Temperature (T2) in Raw Counts
56	Primary Mirror Aperature Stop	Temperature (T3) in Raw Counts
57	Secondary Mirror Shield	Temperature (T4) in Raw Counts

TABLE 4. (Cont.) COMMON DOCUMENTATION (SECOND FIELD)

WORD NUMBER	CONTENTS	DESCRIPTION
58	Black Body Number 1	Temperature (T5) in Raw Counts
59	Black Body Number 2	Temperature (T6) in Raw Counts
60	Scan Mirror	Temperature (T7) in Raw Counts
61	Baffle Tube Forward End	Temperature (T8) in Raw Counts
62	Baffle Tube Aft End	Temperature (T9) in Raw Counts
63	Shutter Cavity	Temperature (T10) in Raw Counts
64	Auxiliary Power Suppply Voltage	+15 Power Supply Voltage in Raw Counts
65	Filter Wheel	Temperature (T11) in Raw Counts NOTE: Words 64 and 65 are made available through GMACS PCM data only. PCM data is updated every 3 minutes. Most recent PCM data is inserted during wideband readouts of Words 54 through 63.
66	VAS Temperature Data Source	1 = Wideband (updated every spin) 2 = PCM (updated approx. every 3 min.)
67	Spare	

TABLE 4. (Cont.) COMMON DOCUMENTATION (SECOND FIELD)

WORD NUMBER	CONTENTS	DESCRIPTION
68	Dwell Sound Spin Number	Current Spectral Band Spin Number (0 to 255) Valid only in DS Mode.
69-99	Spare	
100-113	Calibration Valid Time Interval	The beginning and ending dates of valid calibration data. The word and bit configuration is the same as words 85-98 Common Documentation Field 1.
114-127	Visible Normalization Valid Time Interval	The beginning and ending dates of valid visible normalization data. The word and bit configuration is the same as words 100-113 this Field.
128	Longitudinal Parity	An exclusive-OR of each corresponding 128 bit of all preceding 127 words. The result is then complemented so that the resulting parity is odd.

CHART 5. COMMON DOCUMENTATION (THIRD FIELD)

Bit positions: MSB 1, 2, 3, 4, 5, 6, 7, 8, 9, LSB 10

Word	Bits	Content
1–2	3–10	IR TEMPERATURE
3–4	3–10	IR TEMPERATURE
5–6	3–10	IR TEMPERATURE
7	3–8	
7	9–10	TEMPERATURE CONTROL
8	3–10	SPARE
9	1–10	D_{Z1} EAST DEEP SPACE (RAW)
10	1–10	D_{Z1} WEST DEEP SPACE (RAW)
11	1–10	D_{Z2} EAST DEEP SPACE (RAW)
12	1–10	D_{Z2} WEST DEEP SPACE (RAW)
13–14	3–10	X_{R_1} SHUTTER RADIANCE
15–16	3–10	X_{R_2} SHUTTER RADIANCE
17–18	3–10	X_{Z1}EAST DEEP SPACE
19–20	3–10	X_{Z1}WEST DEEP SPACE

CHART 5. (Cont.) COMMON DOCUMENTATION (THIRD FIELD)

Word	MSB 1	2	3	4	5	6	7	8	9	LSB 10
21–22			X_Z 2EAST DEEP SPACE							
23–24			X_Z 2WEST DEEP SPACE							
25–26			N_1 TOTAL RADIANCE							
27–28			N_2 TOTAL RADIANCE							
29	IR1-R1									
30	IR1-R2									
31	IR1-R3									
32	IR1-R4									
33	IR1-R5									
. . .	. . .									
40	IR1-R12									
41	IR2-R1									
42	IR2-R2									
43	IR2-R3									

CHART 5. (Cont.) COMMON DOCUMENTATION (THIRD FIELD)

Word	MSB 1	2	3	4	5	6	7	8	9	LSB 10
44	IR2-R4									
.	.									
.	.									
52	IR2-R12									
53	IR1 RADIANCE COUNT									
54	IR2 RADIANCE COUNT									
55			SPARE							
56			SPARE							
57			VIS CALIBRATION							
58			VIS CALIBRATION							
59			VIS CALIBRATION							
60			VIS CALIBRATION							
61			VIS CALIBRATION							
62			VIS CALIBRATION							
63			IR CALIBRATION PARAMETERS							
.			.							
76			IR CALIBRATION PARAMETERS							
77			IR CALIBRATION PARAMETERS							
78			IR CALIBRATION PARAMETERS							
79			IR CALIBRATION PARAMETERS							

CHART 5. (Cont.) COMMON DOCUMENTATION (THIRD FIELD)

Word	MSB 1	2	3	4	5	6	7	8	9	LSB 10
80			IR CALIBRATION PARAMETERS							
.			.							
.			.							
.			.							
110			IR CALIBRATION PARAMETERS							
111			IR CALIBRATION PARAMETERS							
112			IR CALIBRATION PARAMETERS							
113			SPARE							
114			SPARE							
115			DETECTOR GEOMETRY PARAMETERS							
.			.							
.			.							
.			.							
125			DETECTOR GEOMETRY PARAMETERS							
126			DETECTOR GEOMETRY PARAMETERS							
127			PREDICTED HEADER							
128	PARITY									

P/DU

TABLE 5. COMMON DOCUMENTATION (THIRD FIELD)

WORD NUMBER	CONTENTS	DESCRIPTION
1-6	Temperature Data Words (RAW Data 9 bits Used, 0000 000X XXXX XXXX) (PROCESSED Data 16 bits Used, XXXX XXXX XXXX XXXX)	These words are time multiplexed with a period of 20 spins and are synchronized with the O&A data. When the O&A Block = 1 and the minor frame index = 1, the first six temperature bytes are output. See Table 5A for the temperature bytes definition.
7	TEMP CONTROL	Bit 9 = 1 VIP used B_ϵ for Temp Calibration = 0 VIP used A_ϵ for Temp Calibration Bit 10 = 1 IR verify temperature used for calibration = 0 PCM temperatures used for calibration
8	SPARE	
9	D_{Z1} EAST	Raw video samples 8-41 (West) and 3782-3815 (East) are summed, the largest and smallest subtracted, averaged.
10	D_{Z1} WEST	
11	D_{Z2} EAST	SAME AS ABOVE
12	D_{Z2} WEST	

TABLE 5. (Cont.) COMMON DOCUMENTATION (THIRD FIELD)

WORD NUMBER	CONTENTS	DESCRIPTION
13-14	X_{R_1}	Radiance data is preprocessed, averaged, bias subtracted, run through video lookup table and linear interpolated using 5 bits of fraction. X_{R_1} and X_{R_2} are SF 0 normalized video. This data is documented with video from previous spin.
15-16	X_{R_2}	Same as above
17-18	X_{Z1EAST}	Video samples 8-41 (west) and 3782-3815 (east) are summed,
19-20	X_{Z1WEST}	largest and smallest subtracted (which is summation of 32
21-22	X_{Z2EAST}	samples) before video is passed through lookup table. This sum
23-24	X_{Z2WEST}	is then passed through a lookup table and linear interpolated using 5 bits of fraction to produce X_Z. X_Z is SF 0 normalized video.
25-26	Effective Blackbody Radiance - N_{k1}	Effective blackbody radiance for IR1 with a scale factor of 0.

TABLE 5. (Cont.) COMMON DOCUMENTATION (THIRD FIELD)

WORD NUMBER	CONTENTS	DESCRIPTION	
27-28	Effective Blackbody Radiance - N_{k2}	Effective blackbody radiance for IR2 with a scale of 0.	
29-40	IR1 Shutter Radiance Samples-(10 bits used)	Raw shutter radiance samples.	
		Word 29	IR1 Sample 1
		Word 30	IR1 Sample 2
		Word 31	IR1 Sample 3
		Word 32	IR1 Sample 4
		Word 33	IR1 Sample 5
		Word 34	IR1 Sample 6
		Word 35	IR1 Sample 7
		Word 36	IR1 Sample 8
		Word 37	IR1 Sample 9
		Word 38	IR1 Sample 10
		Word 39	IR1 Sample 11
		Word 40	IR1 Sample 12
41-52	IR2 Shutter Radiance Samples-(10 bits used)	Raw shutter radiance samples.	
		Word 42	IR2 Sample 1
		Word 43	IR2 Sample 2
		Word 44	IR2 Sample 3
		Word 45	IR2 Sample 4
		Word 46	IR2 Sample 5
		Word 47	IR2 Sample 6
		Word 48	IR2 Sample 7
		Word 49	IR2 Sample 8
		Word 50	IR2 Sample 9
		Word 51	IR2 Sample 10
		Word 52	IR2 Sample 11
		Word 53	IR2 Sample 12

TABLE 5. (Cont.) COMMON DOCUMENTATION (THIRD FIELD)

WORD NUMBER	CONTENTS	DESCRIPTION
53	IR1 Radiance Count (10 bits used)	Number of good IR1 shutter radiance samples.
54	IR2 Radiance Count (10 bits used)	Number of good IR2 shutter radiance samples.
55-56	Spare	
57-62	Visible Calibration Data Word	These words are time multiplexed with a period of 20 spins and are synchronized with the 0+A data. When the 0+A Block = 1 and the MFI = 1, the first 6 calibration bytes are output. See Table 5B for a definition of the visible calibration bytes.
63-112	IR Calibration Data Word	These words are time multiplexed with a period of 20 spins and are synchronized with the 0+A data. When the 0+A Block = 1 and the MFI = 1, the first 50 calibration bytes are output. See Table 5C for a definition of the 884 IR calibration bytes.

TABLE 5. (Cont.) COMMON DOCUMENTATION (THIRD FIELD)

WORD NUMBER	CONTENTS	DESCRIPTION
113-114	Spare	
115-126	Detector Geometry	These words are time multiplexed with a period of 20 spins and are synchronized with O&A data. When O&A Block = 1 and MFI = 1 the first 12 bytes of the detector geometry parameters are output. See Table 5D for definition of 220 detector geometry parameters.
127	Predicted Header (See Section 1, Word 5)	
128	Longitudinal Parity	

TABLE 5A. Temperature Parameters

Common Documentation Word No.	Block Number / Minor Frame Index**	WIDEBAND 1	2	3	4	PCM/GMACS 5	6	7	8	FUTURE 9	10
		1/2*	1/2*	1/2*	1/2*	1/2*	1/2*	1/2*	1/2*	1/2*	1/2*
	(Spin)	1	3	5	7	9	11	13	15	17	19
1 - 2	1***	P1R1	P1R7	R1R1	R1R7	PPCM1	PPCM7	RPCM1	RPCM7	-	-
3 - 4	2***	P1R2	P1R8	R1R2	R1R8	PPCM2	PPCM8	RPCM2	RPCM8	-	-
5 - 6	3***	P1R3	P1R9	R1R3	R1R9	PPCM3	PPCM9	RPCM3	RPCM9	-	-
	(Spin)	2	4	6	8	10	12	14	16	18	20
1 - 2	4***	P1R4	P1R10	R1R4	R1R10	PPCM4	PPCM10	RPCM4	RPCM10	-	-
3 - 4	5***	P1R5	°PIR11	R1R5	°R1R11	PPCM5	PPCM11	RPCM5	RPCM11	-	-
5 - 6	6***	P1R6	-	R1R6	-	PPCM6	-	RPCM6	-	-	-

PIR_n - Processed IR Verify Temperatures $T_1 - T_{10}$ with a scale factor of 6 (XXXXXXXX; XX.XXXXXX) °C

RIR_n - Raw IR Temperatures $T_1 - T_{10}$ with a scale factor of 0. (0000000X; XXXXXXXX. Counts

$PPCM_n$ - Processed PCM Temperatures $T_1 - T_{11}$ with a scale factor of 6 in °C.

$RPCM_n$ - Raw PCM Temperatures $T_1 - T_{11}$ with a scale factor of 0. (See RIR_n in Counts)

\- Spares

* Block Number = Minor Frame Index = 0 if O&A data not present

** Minor Frame Index = 1 if O&A Word Number is less than 7; otherwise MFI = 2

*** Temperature Word Number

° Not Available on Wideband Data (updated every three minutes).

TABLE 5B. Visible Calibration Parameters

Common Documentation Word No.	Block Number*	1	2	3	4	5	6	7	8	9	10
	Minor Frame Index**	1/2	1/2	1/2	1/2	1/2	1/2	1/2	1/2	1/2	1/2
57 - 58	1***	V1(0)	V2(2)	V4(0)	V5(2)	V7(0)	V8(2)	FV5	SERIAL#	-	-
59 - 60	2***	V1(1)	V2(3)	V4(1)	V5(3)	V7(1)	V8(3)	FV6	-	-	-
61 - 62	3***	V1(2)	V3(0)	V4(2)	V6(0)	V7(2)	FV1	FV7	-	-	-
57 - 58	4***	V1(3)	V3(1)	V4(3)	V6(1)	V7(3)	FV2	FV8	-	-	-
59 - 60	5***	V2(0)	V3(2)	V5(0)	V6(2)	V8(0)	FV3	SOURCE	-	-	-
61 - 62	6***	V2(1)	V3(3)	V5(1)	V6(3)	V8(1)	FV4	S/C ID	-	-	-

\- Spares

* Block Number = Minor Frame Index = 0 if O&A data not present

** O+A Minor frame index = 1 if O+A Word Number is less than 7; otherwise MFI = 2

*** Visible Calibration Word Number

TABLE 5B (cont.) Visible Calibration Parameters

Information Byte	Name	Description
1-64	V_n	Visible Nonlinearity Polynominal Coefficients. $V_i = (V_{i0}, V_{i1}, V_{i2}, V_{i3})$ where V_{ij}: Nonlinearity polynominal curve for the visible detector i: $Y_z = \sum_{j=0}^{3} V_{ij} (d/64)^j$ where Y_z is the linearized version of the signal corresponding to a visible sample d where d = 0, 1, 2, 3, ..., 63. The computed results Y_z will be a non-negative integer less than 64 and will have a scale factor of 15 within the VIP.
65-80	FV_n	Visible Nonlinearity Polynominal Coefficients Scale Factor. These are the individual scale factors for all eight V's.
81-82	SOURCE	The most significant eight bits correspond to the source of the visible calibration data and the least significant eight bits correspond to the spacecraft name. 0 = M+T 1 = NESDIS

TABLE 5B (cont.) Visible Calibration Parameters

Information Byte	Name	Description
83-84	S/C Name	Satellite ID 1 - SMS-1 6 - GOES-4 2 - SMS-2 7 - GOES-5 3 - GOES-1 8 - GOES-6 4 - GOES-2 9 - GOES-7 5 - GOES-3 10 - GOES-8
85-86	ID	Serial Number for visible nonlinearity coefficients data set.
87-120	SPARES	

TABLE 5C. IR Calibration Parameters

Common Documentation Word No.	Block Number*	1	2	3	4	5	6	7	8	9	10
	Minor Frame Index**	1	1	1	1	1	1	1	1	1	1
63 - 64	1***	A1(0)	FB6	C10(3)	FC22	E11(0)	FE24	G9(2)	G37(0)	AB13(0)	AB38(0)
65 - 66	2***	A1(1)	-	C11(0)	FC24	E11(1)	FE29	G9(3)	G37(1)	AB13(1)	AB38(1)
67 - 68	3***	A1(2)	DELT	C11(1)	FC29	E11(2)	FE31	G11(0)	G37(2)	AB14(0)	FAB1
69 - 70	4***	A1(3)	FDELT	C11(2)	FC31	E11(3)	FE36	G11(1)	G37(3)	AB14(1)	FAB2
71 - 72	5***	A2(0)	-	C11(3)	FC36	E12(0)	FE38	G11(2)	FG7	AB15(0)	FAB3
73 - 74	6***	A2(1)	DEL15	C12(0)	FC38	E12(1)	-	G11(3)	FG8	AB15(1)	FAB4
75 - 76	7***	A2(2)	FDEL15	C12(1)	-	E12(2)	M1	G12(0)	FG9	AB16(0)	FAB5
77 - 78	8***	A2(3)	-	C12(2)	TFW	E12(3)	M2	G12(1)	FG11	AB16(1)	FAB6
79 - 80	9***	A3(0)	AVN	C12(3)	FTFW	E20(0)	M3	G12(2)	FG12	AB17(0)	FAB7
81 - 82	10***	A3(1)	FAVN	C20(0)	-	E20(1)	M7	G12(3)	FG19	AB17(1)	FAB8
83 - 84	11***	A3(2)	-	C20(1)	E1(0)	E20(2)	M9	G19(0)	FG20	AB18(0)	FAB9
85 - 86	12***	A3(3)	C1(0)	C20(2)	E1(1)	E20(3)	M10	G19(1)	FG21	AB18(1)	FAB10

* Block number = Minor Frame index = 0 if O+A data is not present

** O+A Minor Frame index = 1 if O+A Word Number is less than 7; otherwise, MFI = 2

*** IR Calibration Word Number

TABLE 5C (Cont.) IR Calibration Parameters

Common Documentation Word No.	Block Number*	1	2	3	4	5	6	7	8	9	10
	Minor Frame Index**	1	1	1	1	1	1	1	1	1	1
87 - 88	13***	A4(0)	C1(1)	C20(3)	E1(2)	E22(0)	FM	G19(2)	FG23	AB19(0)	FAB11
89 - 90	14***	A4(1)	C1(2)	C22(0)	E1(3)	E22(1)	-	G19(3)	FG24	AB19(1)	FAB12
91 - 92	15***	A4(2)	C1(3)	C22(1)	E2(0)	E22(2)	W4(1)	G20(0)	FG28	AB20(0)	FAB13
93 - 94	16***	A4(3)	C2(0)	C22(2)	E2(1)	E22(3)	W4(2)	G20(1)	FG29	AB20(1)	FAB14
95 - 96	17***	A5(0)	C2(1)	C22(3)	E2(2)	E24(0)	W4(3)	G20(2)	FG30	AB21(0)	FAB15
97 - 98	18***	A5(1)	C2(2)	C24(0)	E2(3)	E24(1)	W4(4)	G20(3)	FG35	AB21(1)	FAB16
99 - 100	19***	A5(2)	C2(3)	C24(1)	E3(0)	E24(2)	W4(5)	G21(0)	FG36	AB22(0)	FAB17
101 - 102	20***	A5(3)	C3(0)	C24(2)	E3(1)	E24(3)	W4(6)	G21(1)	FG37	AB22(1)	FAB18
103 - 104	21***	A6(0)	C3(1)	C24(3)	E3(2)	E29(0)	W4(7)	G21(2)	SO1	AB23(0)	FAB19
105 - 106	22***	A6(1)	C3(2)	C29(0)	E3(3)	E29(1)	W4(8)	G21(3)	SO2	AB23(1)	FAB20
107 - 108	23***	A6(2)	C3(3)	C29(1)	E4(0)	E29(2)	W4(9)	G23(0)	SO3	AB24(0)	FAB21
109 - 110	24***	A6(3)	C4(0)	C29(2)	E4(1)	E29(3)	W4(10)	G23(1)	SO4	AB24(1)	FAB22
111 - 112	25***	A7(0)	C4(1)	C29(3)	E4(2)	E31(0)	W4(11)	G23(2)	FSO	AB25(0)	FAB23

* Block number = Minor Frame index = 0 if O+A data is not present
** O+A Minor Frame index = 1 if O+A Word Number is less than 7; otherwise, MFI = 2
*** IR Calibration Word Number

TABLE 5C (Cont.) IR Calibration Parameters

Common Documentation Word No.	Block Number*	1	2	3	4	5	6	7	8	9	10
	Minor Frame Index**	2	2	2	2	2	2	2	2	2	2
63 - 64	26***	A7(1)	C4(2)	C31(0)	E4(3)	E31(1)	W4(12)	G23(3)	-	AB25(1)	FAB24
65 - 66	27***	A7(2)	C4(3)	C31(1)	E5(0)	E31(2)	W8(1)	G24(0)	AB1(0)	AB26(0)	FAB25
67 - 68	28***	A7(3)	C5(0)	C31(2)	E5(1)	E31(3)	W8(2)	G24(1)	AB1(1)	AB26(1)	FAB26
69 - 70	29***	A8(0)	C5(1)	C31(3)	E5(2)	E36(0)	W8(3)	G24(2)	AB2(0)	AB27(0)	FAB27
71 - 72	30***	A8(1)	C5(2)	C36(0)	E5(3)	E36(1)	W8(4)	G24(3)	AB2(1)	AB27(1)	FAB28
73 - 74	31***	A8(2)	C5(3)	C36(1)	E6(0)	E36(2)	W8(5)	G28(0)	AB3(0)	AB28(0)	FAB29
75 - 76	32***	A8(3)	C6(0)	C36(2)	E6(1)	E36(3)	W8(6)	G28(1)	AB3(1)	AB28(1)	FAB30
77 - 78	33***	A9(0)	C6(1)	C36(3)	E6(2)	E38(0)	W8(7)	G28(2)	AB4(0)	AB29(0)	FAB31
79 - 80	34***	A9(1)	C6(2)	C38(0)	E6(3)	E38(1)	W8(8)	G28(3)	AB4(1)	AB29(1)	FAB32
81 - 82	35***	A9(2)	C6(3)	C38(1)	E7(0)	E38(2)	W8(9)	G29(0)	AB5(0)	AB30(0)	FAB33
83 - 84	36***	A9(3)	C7(0)	C38(2)	E7(1)	E38(3)	W8(10)	G29(1)	AB5(1)	AB30(1)	FAB34
85 - 86	37***	A10(0)	C7(1)	C38(3)	E7(2)	FE1	W8(11)	G29(2)	AB6(0)	AB31(0)	FAB35

* Block number = Minor Frame index = 0 if O+A data is not present

** O+A Minor Frame index = 1 if O+A Word Number is less than 7; otherwise, MFI = 2

*** IR Calibration Word Number

TABLE 5C (Cont.) IR Calibration Parameters

Common Documentation Word No.	Block Number*	1	2	3	4	5	6	7	8	9	10
	Minor Frame Index**	2	2	2	2	2	2	2	2	2	2
87 - 88	38***	A10(1)	C7(2)	FC1	E7(3)	FE2	W8(12)	G29(3)	AB6(1)	AB31(1)	FAB36
89 - 90	39***	A10(2)	C7(3)	FC2	E8(0)	FE3	FW	G30(0)	AB7(0)	AB32(0)	FAB37
91 - 92	40***	A10(3)	C8(0)	FC3	E8(1)	FE4	—	G30(1)	AB7(1)	AB32(1)	FAB38
93 - 94	41***	A11(0)	C8(1)	FC4	E8(2)	FE5	G7(0)	G30(2)	AB8(0)	AB33(0)	SOURCE
95 - 96	42***	A11(1)	C8(2)	FC5	E8(3)	FE6	G7(1)	G30(3)	AB8(1)	AB33(1)	S/C
97 - 98	43***	A11(2)	C8(3)	FC6	E9(0)	FE7	G7(2)	G35(0)	AB9(0)	AB34(0)	ID
99 - 100	44***	A11(3)	C9(0)	FC7	E9(1)	FE8	G7(3)	G35(1)	AB9(1)	AB34(1)	-
101 - 102	45***	FA	C9(1)	FC8	E9(2)	FE9	G8(0)	G35(2)	AB10(0)	AB35(0)	-
103 - 104	46***	-	C9(2)	FC9	E9(3)	FE10	G8(1)	G35(3)	AB10(1)	AB35(1)	-
105 - 106	47***	B6(0)	C9(3)	FC10	E10(0)	FE11	G8(2)	G36(0)	AB11(0)	AB36(0)	-
107 - 108	48***	B6(1)	C10(0)	FC11	E10(1)	FE12	G8(3)	G36(1)	AB11(1)	AB36(1)	-
109 - 110	49***	B6(2)	C10(1)	FC12	E10(2)	FE20	G9(0)	G36(2)	AB12(0)	AB37(0)	-
111 - 112	50***	B6(3)	C10(2)	FC20	E10(3)	FE22	G9(1)	G36(3)	AB12(1)	AB37(1)	-

- Spares
* Block number = Minor Frame index = 0 if O+A data is not present
** O+A Minor Frame index = 1 if O+A Word Number is less than 7; otherwise, MFI = 2
*** IR Calibration Word Number

TABLE X. IR Calibration Parameters

Information Byte	Name	Description
1 - 88	A1(0)-(3) to A11(0)-(3)	11 sets of cubic polynomial coefficients to convert raw PCM data to temperatures.
89 - 90	FA	Scale factor for A coefficients.
91 - 92	SPARE	
93 - 100	B6(0)-(3)	Cubic polynomial coefficients to evaluate black body temperatures.
101 - 102	FB6	Scale factor for B6.
103 - 104	SPARE	
105 - 106	Delt	Acceptable temperature change.
107 - 108	FDelt	Scale factor for Delt.
109 - 110	SPARE	
111 - 112	DeL 15	Acceptable +15 auxiliary voltage change.
113 - 114	FDeL 15	Scale factor for DeL 15.
115 - 116	SPARE	
117 - 118	AVN	Nominal +15 aux voltage.
119 - 120	FAVN	Scale factor for AVN.
121 - 122	SPARE	
123 - 218	C1(0)-(3) to C12(0)-(3)	19 sets of cubic polynomial coefficients to convert temperature to radiance.
219 - 226	C20(0)-(3)	
227 - 234	C22(0)-(3)	
235 - 242	C24(0)-(3)	
243 - 250	C29(0)-(3)	
251 - 258	C31(0)-(3)	
259 - 266	C36(0)-(3)	
267 - 274	C38(0)-(3)	
275 - 298	FC1 to FC12	Scale factors for C's
299 - 300	FC20	
301 - 302	FC22	
303 - 304	FC24	
305 - 306	FC29	
307 - 308	FC31	
309 - 310	FC36	
311 - 312	FC38	
313 - 314	SPARE	
315 - 316	TFW	Nominal temperature of the filter wheel
317 - 318	FTFW	Scale factor for TFW
319 - 320	SPARE	
321 - 416	E1(0)-(3) to E12(0)-(3)	19 sets of cubic polynomial coefficients to account band shifts due filter wheel temperature excusion.
417 - 424	E20(0)-(3)	
425 - 432	E22(0)-(3)	
433 - 440	E24(0)-(3)	
441 - 448	E29(0)-(3)	
449 - 456	E31(0)-(3)	
457 - 464	E36(0)-(3)	
465 - 472	E38(0)-(3)	
473 - 496	FE1 to FE12	Scale factors for the E's.

TABLE 5C. (Cont.) IR Calibration Parameters

Information Byte	Name	Description
497 - 498	FE20	
499 - 500	FE22	
501 - 502	FE24	
503 - 504	FE29	
505 - 506	FE31	
507 - 508	FE36	
509 - 510	FE38	
511 - 512	SPARE	
513 - 514	M1	Radiance Weighing factors
515 - 516	M2	
517 - 518	M3	
519 - 520	M7	
521 - 522	M9	
523 - 524	M10	
525 - 526	FM	Scale Factor for M's
527 - 528	SPARE	
529 - 552	W4(1)-(12)	12 coefficients for secondary Mirror Shield
553 - 576	W8(1)-(12)	12 coeffients for Baffle Forward
577 - 578	FW	Scale factor for all 24 W's
579 - 580	SPARE	
581 - 708	$G_k(0)-(3)$	16 sets of thermal nonlinearity cubic polynomial coefficients for K=7, 8, 9, 11, 12, 19, 20, 21, 23, 24, 28, 29, 30, 35, 36, 37. These are the 16 possible amplifier gain and filter combinations.
709 - 740	FG_k	16 Scale factors, one for each individual polynomial.
741 - 742	SO1	IR1 28 MPS shutter radiance offset
743 - 744	SO2	IR2 28 MPS shutter radiance offset
745 - 746	SO3	IR1 14 MPS shutter radiance offset
747 - 748	SO4	IR2 14 MPS shutter radiance offset
749 - 750	FSO	Scale factor for all 4 SO's
751 - 752	SPARE	
753 - 904	$AB_k(0)$ to $AB_k(1)$	k = 1 to 38 pairs for the radiance equation $RAD=2^{-FAB_k}(AB_k(1)*X-AB_k(0))$ where X is the processed count from the VIP
905 - 980	FAB	38 scale factors for the AB's
981 - 982	Source	Source of data, 0 = M+T, 1 = NESDIS
983 - 984	S/C Name	Satellite ID 1 = SMS-1 6 = GOES-4 2 = SMS-2 7 = GOES-5 3 = GOES-1 8 = GOES-6 4 = GOES-2 9 = GOES-7 5 = GOES-3 10 = GOES-8
985 - 986	Serial Number	Serial number of the IR calibration data. The most significant eight bits correspond to the source of the IR calibration data and the least significant eight bits correspond to the spacecraft name.
986 - 1000	SPARES	

IR CALIBRATION PARAMETERS

BYTE	NAME	DESCRIPTION
1-88	A_1 - A_{11}	Temperature Calibration $A_i = (a_{i0}, a_{i1}, a_{i2}, a_{i3})$ where a_{ij}: Temperature sensor calibration curve polynominal coeffient for normal state of sensor

$$T_i = \sum_{j=0}^{3} a_{ij} t_i$$

where T_i is temperature in $^{\circ}C$ for temperature sensor i as defined below:

- T_1 Secondary Mirror
- T_2 Primary Mirror
- T_3 Primary Mirror Mask
- T_4 Secondary Mirror Shield
- T_5 Blackbody Sensor 1
- T_6 Blackbody Sensor 2
- T_7 Scan Mirror
- T_8 Baffle Tube Forward
- T_9 Baffle Tube Aft
- T_{10} Shutter Cavity
- T_{11} Filter Wheel

Also:

$$t_i = S_i/AV$$

where S_i is temperature sensor digital telemetry reading and AV is the digital telemetry reading for

IR CALIBRATION PARAMETERS (Cont.)

BYTE	NAME	DESCRIPTION
		the state of the +15 volt auxiliary power supply. Bytes 1-2 will contain a 16 bit integer a_{10}, bytes 3-4 will contain a_{11}, ..., bytes 79-80 will contain $a_{10,3}$. Negative numbers will be in two's complement form. The a_{ij} numbers will each have scale factor 7 which indicates that the binary point is located to the right of the 10th binary digit counting from the most significant bit (MSB) at the left. Thus, if the contents of bytes 3-4 is 11167, then $$a11 = 43.621 = \frac{11167}{2^{15-7}}$$ It is assumed that $0 \leq t_i < 2$ and $\mid a_{ij}(t_i)^j \mid < 128$. It is further assumed the $\mid T_i^{(m)} \mid < 128$ for m = 1, 2 and $\mid (T_i)^m \mid < 64$ for m = 3 where $$T_i^{(m)} = \sum_{j=0}^{m} a_{ij}\, t_i$$
89-90	FA	Temperature Calibration Scale factor for eleven A's.
91-92	SPARE	
93-100	B_6	Temperature Calibration $B_6 = (b_{61}, b_{62}, b_{63}, b_{64})$ where b_{6j} is temperature sensor calibration curve polynominal coefficient

IR CALIBRATION PARAMETERS (Cont.)

BYTE	NAME	DESCRIPTION
		for high state of sensor. B_6 is used in lieu of A_6 when selected. All b_{6j} numbers satisfy the conditions for the a_{ij} numbers.
101-102	FB_6	Temperature calibration scale factor for all B_6's.
103-104	SPARE	
105-106	Delta T	Acceptable PROC Temperature Change Each time a new temperature T_i is determined from the PCM data it is compared to the prior value of that temperature T_i'. If $\lvert T_i - T_i' \rvert >$ Delta T, T_i' will be used but T_i will be saved and used in the next Delta T comparison. If $\lvert T_i - T_i' \rvert \leq$ Delta T, T_i will be used. The Delta T scale factor is 6; thus the smallest increment to which Delta T can be specified is 0.002°C.
107-108	FDelta T	Acceptable Processed Temperature change scale factor.
109-110	SPARE	

IR CALIBRATION PARAMETERS (Cont.)

BYTE	NAME	DESCRIPTION
111-112	Delta 15	Acceptable 15V Power Supply Change. Each time a new auxiliary voltage AV is determined from the PCM data it is compared to the prior value AV'. If $\lvert AV - AV' \rvert >$ Delta 15, AV' will be used but AV will be saved and used in the next Delta 15 comparison; if $\lvert AV - AV' \rvert \leq$ Delta 15, AV' will be used. The Delta 15 scale factor is 15 which is an integer representation.
113-114	FDelta 15	Acceptable 15 VPS Change Scale Factors
115-116	SPARE	
117-118	AVN	Nominal +15V Aux Voltage. This number is used in lieu of AV when processing the verify mode temperatures.
119-120	FAVN	Nominal + 15V Aux Voltage Scale Factor for AVN.
121-122	SPARE	
123-274	$C_1 - C_{12}$, C_{20}, C_{22}, C_{24}, C_{29}, C_{31}, C_{36}, C_{38}	Radiance Polynomial Coefficients $C_k = (c_{k0}, c_{k1}, c_{k2}, c_{k3})$ c_{kj}: Coefficients to compute radiance for band-detector k for object with temperature T_i

IR CALIBRATION (Cont.)

BYTE	NAME	DESCRIPTION
		$$R_{ki} = \sum_{j=0}^{3} C_{kj}(T_i/64)^j$$ and R_{ki} is radiance from set k. The relation between k and the band-detectors is as shown in Table 5A1. For C_i values not defined in bytes 123-274 use equivalence table below.
275-312	$FC_1 - FC_{12}$, FC_{20}, FC_{22}, FC_{24}, FC_{29}, FC_{31}, FC_{36}, FC_{38}	Radiance Polynomial Coefficients Scale Factors The number F_k is used with the C_k coefficients to denote their scale factor. Thus, if FC_1 = 6 and the contents of bytes 123-124 is 13524, then C_{10} = 26.414. Byte 275 contains FC_1, etc.
313-314	SPARE	
315-316	TFW	Filter Wheel Temperature This is the nominal filter wheel temperature used to correct spectral shifts due to filter wheel excursions.
317-318	FTFW	Filter Wheel Temperature Scale Factor for TFW.
319-320	SPARE	

IR CALIBRATION PARAMETERS (Cont.)

BYTE	NAME	DESCRIPTION	
		Undefined k Value	Equivalent k Value
		13	1
		14	2
		15	3
		16	4
		17	5
		18	6
		19	7
		21	9
		23	11
		25	3
		26	4
		27	5
		28	7
		30	9
		32	3
		33	4
		34	5
		35	7
		37	9

Bytes 123-124 are used for c_{10}, etc; thus, bytes 123-130 are used for C_1 and bytes 267-274 are used for c_{38}. The C_k scale factors are discussed below.

TABLE 5C1. ORDER OF FILTER DETECTOR COMBINATIONS

k	Detector	Size	Location*	Band
1	HgCdTe	L	U	1
2	│	│	│	2
3	│	│	│	3
4	│	│	│	4
5	│	│	│	5
6	InSb	│	│	6
7	HgCdTe	│	│	7
8	│	│	│	8
9	│	│	│	9
10	│	│	│	10
11	InSb	│	│	11
12	│	│	│	12
13	HgCdTe	│	L	1
14	│	│	│	2
15	│	│	│	3
16	│	│	│	4
17	│	│	│	5
18	InSb	│	│	6
19	HgCdTe	│	│	7
20	│	│	│	8
21	│	│	│	9
22	│	│	│	10
23	InSb	│	│	11
24	│	│	│	12
25	HgCdTe	S	U	3
26	│	│	│	4
27	│	│	│	5
28	│	│	│	7
29	│	│	│	8
30	│	│	│	9
31	│	│	│	10
32	│	│	L	3
33	│	│	│	4
34	│	│	│	5
35	│	│	│	7
36	│	│	│	8
37	│	│	│	9
38	│	│	│	10

*U or upper detector channel is also called IR1;
L or lower detector channel is also called IR2.

IR CALIBRATION (Cont.)

BYTE	NAME	DESCRIPTION
321-472	E_1 - E_{12}, E_{20}, E_{22}, E_{24}, E_{29}, E_{31}, E_{36}, E_{38}	Filter Wheel Temperature Polynomial n Coefficients. E_k = (E_{k0}, E_{k1}, E_{k2}, E_{k3}) account for bandshifts due to filter wheel temperature excusions. These coefficients are used in the expression shown below : $\Delta\ R_{ki} = (T_{11} - T_{FW}) * \sum_{j=0}^{3} E_{kj} T_i^j$ where R_{ki} is the radiance correction from set k. The corrected radiance is then given by $R^1_{ki} = R_{ki} + R_{ki}$ The same 19 sets of coefficients supplied for the radiance are shown below: k = 1-12, 20, 22, 24, 29, 31, 36, 38 For k values not defined use the equivalance table on page 79.
473-510	FE	Scale factors for the filter wheel temperature coefficients (E's).
511-512	SPARE	

IR CALIBRATION (Cont.)

BYTE	NAME	DESCRIPTION
513-524	M_1, M_2, M3, M7, M9, M10	Radiance Weighting Factors - Band Independent Used to compute N_k which is the total radiance from an equivalent blackbody for band-detector k. $N_k = R_{kbb} + \sum_{i=1,2,3,7,9,10} M_i (R_{kbb} - R_{ki}) + \sum_{i=4,8} W_{ki} (R_{kbb} - R_{ki})$ $R_{kbb} = \frac{R_{k5} + R_{k6}}{2}$ Six sets of weighing factors are supplied. These sets are: k = (1, 2, 3, 7, 9, 10)
525-526	FM	Radiance Weighing Factors Scale Factor for all six M's
527-528	SPARE	
529-576	W_4 (1-12) W_8 (1-12)	Radiance Weighting Factors - Band Dependent Two sets of weighing factors are supplied. These sets are for temperatures T_4 and T_8 (Secondary minor shield and baffle forward respectively).
577-578	FW	Radiance Weighing Factor Scale Factor for all W's.
579-580	SPARE	

IR CALIBRATION (Cont.)

BYTE	NAME	DESCRIPTION
581-708	G_7, G_8, G_9, G_{11}, G_{12}, G_{19}, G_{20}, G_{21}, G_{23}, G_{24}, G_{28}, G_{29}, G_{30}, G_{35}, G_{36}, G_{37},	Thermal Nonlinearity Polynomial Coefficients $G_k = (g_{k0}, g_{k1}, g_{k2}, g_{k3})$ where g_{kj} generates the nonlinearity polynomial curve for detector-band set k $X_k = 1024 \sum_{j=0}^{3} [g_{kj}(d/1024)^j]$ where X_k is the linearized version of the signal corresponding to a sample d. Bytes 581-582 are used for g_{70}, ..., bytes 581-588 are used for g_{73}; hence G_7 is contained in bytes 581-588. Sixteen sets of coefficients are supplied. These are: K = (7, 8, 9, 11, 12, 19, 20, 21, 23, 24, 28, 29, 30, 35, 36, 37). For G_k values not defined in bytes 581-708 use the equivalence table below.
709-740	FGK	Thermal Non-linearity polynomial coefficients scale factors for the 16 G's.
741-748	SO_1 - SO_4	Shutter Radiance Offset SO_1 = 28 MBP's, upper detector SO_2 = 28 MBP's, lower detector SO_3 = 14 MBP's, upper detector (not used) SO_4 = 14 MBP's, lower detector (not used)

Undefined k Value	Equivalent k Value
1	9
2	7
3	7
4	7
5	7
6	11
10	7
13	21
14	19
15	19
16	19
17	19
18	23
22	19
25	28
26	28
27	28
31	28
32	35
33	35
34	35
38	35

The sample value d will be an integer 0, 1, ..., 1023. The computed result X_k will be a non-negative number less than 1 and will have scale factor 0 within the VIP. Each of the g_{kj} coefficients will have scale factor 0.

IR CALIBRATION (Cont.)

BYTE	NAME	DESCRIPTION
		SO_1 is contained in bytes 669-670. This offset is caused by the ramp added to the shutter radiance signal. This number will be subtracted from the average of the samples representing this radiance.
749-750	FSO	Shutter Radiance Offset Scale Factor for all SO's.
751-752	SPARE	
753-904	$AB_k(0), AB_k(1)$	Radiance Equation Coefficients. The computed target radiance for each IR sample is mapped into a dynamic range in order to use the full 10 bit IR range for retransmission and to remove any negative numbers. The radiance equation: $$RAD = \frac{[AB_k\ (1) * X - AB_k\ (0)]}{2^{(15-FAB_k)}}$$ where X = the retransmitted processed count from the VIP is used by the user to arrive at the calibrated target radiance for each sample. There are 38 sets of coefficients supplied for all filter-detector combinations.

IR CALIBRATION (Cont.)

BYTE	NAME	DESCRIPTION
905-980	FAB	Radiance Equation Coefficients Scale Factors. These are the scale factors for all 38 AB's.
981-982	SOURCE	Source of Data, 0 = M & T 1 = NESDIS
983-984	S/C NAME	Satellite ID 1 = SMS-1 6 = GOES-4 2 = SMS-2 7 = GOES-5 3 = GOES-1 8 = GOES-6 4 = GOES-2 9 = GOES-7 5 = GOES-3 10 = GOES-8
985-986	SERIAL NUMBER	Serial number of the IR calibration data. data. The most significant eight bit corresponds to the source of the IR calibration data and the least significant eight bits corresponds to the spacecraft name.
987-1000	SPARES	

TABLE 5D. Detector Geometry Parameters

Common Documentation Word No.	Block Number*	1	2	3	4	5	6	7	8	9	10
	Minor Frame Index**	1/2	1/2	1/2	1/2	1/2	1/2	1/2	1/2	1/2	1/2
115 - 116	1***	Q1	Q13	Q25	Q37	P9	P21	P33	R5	H9	S/C ID
117 - 118	2***	Q2	Q14	Q26	Q38	P10	P22	P34	R6	H10	SERIAL#
119 - 120	3***	Q3	Q15	Q27	FG	P11	P23	P35	FR	H11	-
121 - 122	4***	Q4	Q16	Q28	-	P12	P24	P36	-	H12	-
123 - 124	5***	Q5	Q17	Q29	P1	P13	P25	P37	H1	FH	-
125 - 126	6***	Q6	Q18	Q30	P2	P14	P26	P38	H2	-	-
115 - 116	7***	Q7	Q19	Q31	P3	P15	P27	FP	H3	DG1	-
117 - 118	8***	Q8	Q20	Q32	P4	P16	P28	-	H4	DG2	-
119 - 120	9***	Q9	Q21	Q33	P5	P17	P29	R1	H5	DG3	-
121 - 122	10***	Q10	Q22	Q34	P6	P18	P30	R2	H6	FDG	-
123 - 124	11***	Q11	Q23	Q35	P7	P19	P31	R3	H7	-	-
125 - 126	12***	Q12	Q24	Q36	P8	P20	P32	R4	H8	SOURCE	-

- Spares

* Block Number = Minor Frame Index = 0 if O&A data not present
** O+A Minor frame index = 1 if O+A Word Number is less than 7; otherwise MFI = 2
*** Detector Geometry Word Number

TABLE 5D. DETECTOR GEOMETRY PARAMETERS

BYTE	DESCRIPTION	
1-76	Q1-Q38	N-S SPACING
77-78	FQ	
79-80	SPARE	
81-156	P1-P38	E-W SPACING
157-158	FP	
159-160	SPARE	
161-172	R1-R6	E-W DELTA SPACING
173-174	FR	
175-176	SPARE	
177-200	H1-H12	HORIZON THRESHOLD
210-202	FH	
203-204	SPARE	
205-210	DG1-DG3	DELTA GAMMA ANGLE
211-212	FDG	
213-214	SPARE	
215-216	SOURCE	
217-218	S/C NAME	
219-220	SERIAL NUMBER	
221-240	SPARES	

DETECTOR GEOMETRY

BYTE	NAME	DESCRIPTION
1-76	Q1-Q38	North-South Detector Spacing. For each detector-filter combination K, QK is the north-south deviation of the center of the field-of-view (FOV) from its nominal position. A northerly deviation will be positive; negative numbers will be in two's complement form. The quantity Q1 is contained in bytes 1-2. The most significant byte of each 16-bit word will contain the integer number of the deviation in units of scan mirror steps (Pi/2^{14} radians, approximately 196 micro radians). This is a scale factor 7 representation.
77-78	FQ	North-South Detector Spacing Scale Factor which applies to all 38 Q's.
79-80	SPARE	
81-156	P1-P38	East-West Detector Spacing. PK is the east-west spacing of the center of the field-of-view of the northern most visible detector V1 and the detector-filter combination K. A westerly deviation will be

DETECTOR GEOMETRY (Cont.)

BYTE	NAME	DESCRIPTION
		positive; negative numbers are not permitted. The quantity P1 is contained in bytes 81-82. Each 16 bit word will contain the integer number of this spacing in beta angle units (2 Pi/ 6289920 radians, approximately one micro radian). This is a scale factor 15 representation.
157-158	FP	East-West Detector Spacing Scale Factor which applies to all 38 P's.
159-160	SPARE	
161-172	R1 - R2	East-West Delta Spacing. The VIP will normally operate in the 28 MBP's equal angle (EA) mode and the PK quantities are expected to be measured in this mode. In the 14 MBP's EA mode the east-west detector spacing employed by the VIP will be PK + R1 for K = 1-12, 25-31 and PK + R2 for the other K values. Negative values for RN are permitted and will use two's complement notation. RN will have the same scale factor as PK.

DETECTOR GEOMETRY (Cont.)

BYTE	NAME	DESCRIPTION
173-174	FR	East-West Delta Scale Factor applied to R1 and R2.
175-176	SPARE	
177-200	H1 - H12	Horizon Threshold. The quantity HK is used by the VIP to detect the east and west earth horizons as seen by band-detector set K. For HK values not defined in bytes 177-200 use the equivalence table below. The HK is used as a threshold to compare with the X_K linearized signal values (see calibration description).
201-202	FH	Scale Factor for all 12 H's.
203-204	SPARE	
205-210	DG1	Delta gamma angle. This angle will be added to the beta prime angle computed from the chebyshev beta parameters in the O&A data. DG1 is also used with 14 MBP's EA. Scaling of these numbers is the same as PK. Negative numbers are permitted and are represented in two's complement form.

DETECTOR GEOMETRY (Cont.)

BYTE	NAME	DESCRIPTION	
		Undefined k Value	Equivalent k Value
		13	1
		14	2
		15	3
		16	4
		17	5
		18	6
		19	7
		20	8
		21	9
		22	10
		23	11
		24	12
		25	3
		26	4
		27	5
		28	7
		29	8
		30	9
		31	10
		32	3
		33	4
		34	5
		35	7
		36	8
		37	9
		38	10

DETECTOR GEOMETRY (Cont.)

BYTE	NAME	DESCRIPTION
211-212	FDG	Scale Factor for DG1.
213-214	SPARE	
215-216	SOURCE	Source of Data 0 = M & T 1 = NESDIS
217-218	S/C NAME	Satellite ID 1 = SMS-1 6 = GOES-4 2 = SMS-2 7 = GOES-5 3 = GOES-1 8 = GOES-6 4 = GOES-2 9 = GOES-7 5 = GOES-3 10 = GOES-8
219-220	Serial Number	Serial number of detector geometry data.
221-240	SPARES	

CHART 6. COMMON DOCUMENTATION (FOURTH FIELD)

GENERATED IN TOTAL BY THE P/DU

<table>
<tr><th>Word</th><th>MSB
1</th><th>2</th><th>3</th><th>4</th><th>5</th><th>6</th><th>7</th><th>8</th><th>9</th><th>LSB
10</th></tr>
<tr><td>1</td><td></td><td></td><td colspan="8">SPARE</td></tr>
<tr><td>2</td><td></td><td></td><td colspan="8">SPARE</td></tr>
<tr><td>.
.
.</td><td></td><td></td><td colspan="8">.
.
.</td></tr>
<tr><td>76</td><td></td><td></td><td colspan="8">SPARE</td></tr>
<tr><td>77</td><td></td><td></td><td colspan="8">NEXT O&A</td></tr>
<tr><td>78</td><td></td><td></td><td colspan="8">NEXT O&A</td></tr>
<tr><td>.
.
.</td><td></td><td></td><td colspan="8">.
.
.</td></tr>
<tr><td>100</td><td></td><td></td><td colspan="8">NEXT O&A</td></tr>
<tr><td>101</td><td></td><td></td><td colspan="8">FUTURE O&A</td></tr>
<tr><td>102</td><td></td><td></td><td colspan="8">FUTURE O&A</td></tr>
<tr><td>.
.
.</td><td></td><td></td><td colspan="8">.
.
.</td></tr>
<tr><td>120</td><td></td><td></td><td colspan="8">FUTURE O&A</td></tr>
</table>

CHART 6. (Cont.) COMMON DOCUMENTATION (FOURTH FIELD)

GENERATED IN TOTAL BY THE P/DU

Word	MSB 1	2	3	4	5	6	7	8	9	LSB 10
121			FUTURE O&A							
122			.							
123			.							
124			FUTURE O&A							
125			SPARE							
126			SPARE							
127			SPARE							
128			LONGITUDINAL PARITY							

TABLE 6. COMMON DOCUMENTATION (FOURTH FIELD)

WORD NUMBER	CONTENTS	DESCRIPTION
1-76	Spare	
77-100	Next O&A Data	This data is in identical format to O&A data currently in use (words 101-124 Section 1); however, this data is for the time period following the current O&A time period.
101-124	Future O&A	This data is in identical format to O&A data currently in use (words 101-124 Section 1); however, this data is for the time period following the Next O&A Data time period.
125-127	Spare	
128	Parity	

3.3.3.5 Gridding Information

There are provisions for up to 512 infrared and visible grid points (512 two-word pairs or 1024 words) per satellite scan in each of the two IR blocks. However, the space for gridding information in block number three is not presently used but is reserved for special gridding information to be defined at a later date. The location of the infrared grid point pixel is defined by twelve (12) bits uniquely specifying any of the 3822 infrared video locations.

The ten (10) MSB's of the IR pixel are positioned in the first of the 20 bit word pair. The remaining two LSB's of the IR grid pixel are positioned in bits 1 and 2 of the second ten-bit word of the pair. A one count refers to the first pixel of the 3822 IR Pixel locations. All ones is an indication of no grid point.

The visible grid pixel location is defined in a 8 x 4 grid superimposed on the IR pixel location previously specified. The exact location of the visible grid pixel is defined by the 5 LSB's of the second word in the grid location pair. Bits 6-8 identify the line number (1-8) and bits 9 and 10 identify the column (1-4). Bits 3-5 in the second word are presently zeroed but are reserved for future assignment.

CHART 7. GRIDDING INFORMATION

<table>
<tr><th>Word</th><th>1</th><th>2</th><th>3</th><th>4</th><th>5</th><th>6</th><th>7</th><th>8</th><th>9</th><th>10</th></tr>
<tr><td>1</td><td colspan="10">IR GRID PIXEL LOCATION</td></tr>
<tr><td>2</td><td colspan="2">IR LSB</td><td colspan="3">TAG FIELD</td><td colspan="5">VIS PIXEL</td></tr>
<tr><td>3</td><td colspan="10">IR GRID PIXEL LOCATION</td></tr>
<tr><td>4</td><td colspan="2">IR LSB</td><td colspan="3">TAG FIELD</td><td colspan="5">VIS PIXEL</td></tr>
<tr><td>.</td><td colspan="10">.</td></tr>
<tr><td>.</td><td colspan="10">.</td></tr>
<tr><td>.</td><td colspan="10">.</td></tr>
<tr><td>1023</td><td colspan="10">IR GRID PIXEL LOCATION</td></tr>
<tr><td>1024</td><td colspan="2">IR LSB</td><td colspan="3">TAG FIELD</td><td colspan="5">VIS PIXEL</td></tr>
</table>

TABLE 7. GRIDDING INFORMATION

WORD NUMBER	CONTENTS	DESCRIPTION		
1-2	Grid point	Word 1	Bits 1-10	MSB of IR Grid point location
		Word 2	Bits 1-2	LSB of IR Grid point location
			Bits 3-5	The Tag field designates grid set membership. The general purpose grid set (as used previously with Mode A), has a Tag field of all zeros. Other grid sets have not, as yet, been defined.
			Bits 6-8	Row number of an 8 x 4 matrix superimposed on IR pixel
			Bits 9-10	Column number of 8 x 4 matrix superimposed on IR pixel
		NOTE:	Bits 6-10 of Word 2 identifies the location of a visible grid point within an IR pixel.	
3-1024	Repeat of the above 512 times			

3.3.3.6 Mode A IR Documentation

The Mode A IR Documentation field contains the same information as the 128 word IR Documentation field in the previously used Mode A retransmission format. It is included in this, Mode AAA, format primarily to aid users in the transition from Mode A to Mode AAA. The differences in the contents of this field in the triple A format and the older Mode A format are 10 bit words are now used as opposed to 9 bit words in the previous format and telemetry data is not included. When the space-craft instrument is in either the VISSR or the three channel MSI mode the Mode A IR Documentation field can be used to acquire a conventional IR or visible image.

The following Chart 8 and Table 8 show the organization and describe the contents of this field. It should be noted several words in the Mode A documentation are obsolete in Mode AAA. Hence, fixed values are used in the Mode A documentation.

NOTE: The Mode A IR Documentation is generated in total by the P/DU.

CHART 8. MODE A IR DOCUMENTATION

GENERATED IN TOTAL BY THE P/DU

Word	MSB 1	2	3	4	5	6	7	8	9	LSB 10
1			RETRACE							
2			S/C NAME				P/DU		VIP	
3			S/C NAME BCD MSD				LSD			
4			FRAME CODE							
5			CHANGE CODE							
6			STEP CODE							
7			SPARE							
8			0	0	0	0	0	IR SEL AVG	2	1
9			GRAY SCALE STATUS							
10			DIRECT TRANSMISSION MODE							
11			IMAGE COUNT THOU				HUN			
12			IMAGE COUNT TEN				ONE			
13			SCAN MODE							
14			0	BETA (MSB's)						
15			BETA (MID's)							
16			BETA (LSB's)							
17			GRID/NO GRID							
18			PLL ERROR							
19			PLL ERROR							0
20			BIT ERROR COUNT							

CHART 8. MODE A IR DOCUMENTATION (Cont.)

Word	MSB 1	2	3	4	5	6	7	8	9	LSB 10
21			BIT ERROR COUNT					0	0	0
22			SETUP ERROR							
			COMPUTER ERRORS							
23			0	N	0	0	0	0	EX	T
			COMPUTER ERRORS							
24			BETA	MAG	SR	0	0	0	0	0
			SCAN COUNT							
25			THOU				HUN			
			SCAN COUNT							
26			TEN				ONE			
			TIME - YEAR							
27			THOU				HUN			
			TIME - YEAR							
28			TEN				ONE			
							TIME - DAY			
29			0	0	0	0	HUN			
			TIME - DAY							
30			TEN				ONE			
			TIME - HOUR							
31			TEN				ONE			
			TIME - MINUTE							
32			TEN				ONE			
			TIME - SECOND							
33			TEN				ONE			
			TIME - MSEC							
34			HUN				TEN			
35			BLACK ENABLE							
36			SPARE							
							BIT/FRAME			
37			0	0	0	0	BFL	FR	BIT	ANY
38			LIMITED SCAN MODE							
39			SAMPLE CONTROL							
40			VISIBLE CHANNEL CONNECT							

CHART 8. MODE A IR DOCUMENTATION (Cont.)

MSB 1	2	3	4	5	6	7	8	9	LSB 10

Word	3	4	5	6	7	8	9	10
41	SCAN DIRECTION							
42	BI PHASE MODULATION ON/OFF							
43	SCANNER SELECT							
44	PLL ERROR							
						TEST		
45	0	0	0	0	0	C	R	L
46	DATA RANDOMIZATION							
47	SUN PULSE SELECT							
							NESS	
48	0	0	0	0	0	0	4x2	SV
49	IR2 TABLE ID							
50	PREDICTED HEADER							
51	BIT ERROR							
52	MEAN IR							
53	RMS IR							
54	CORR TAB (MSB's)							
55	IR1 TABLE ID							
56	LEFT HORIZON (MSB's)							
57	LEFT HORIZON (LSB's)							
58	RIGHT HORIZON (MSB's)							
59	RIGHT HORIZON (LSB's)							
60	EQUATORIAL SCAN (MSB's)							

CHART 8. MODE A IR DOCUMENTATION (Cont.)

Word	MSB 1	2	3	4	5	6	7	8	9	LSB 10
61	EQUATORIAL SCAN (LSB's)									
62	SPARE									
63	SPARE									
64	SPARE									
65	SPARE									
66	ELEVATION ANGLE (MSB's)									
67	ELEVATION ANGLE (LSB's)									
68	BLACKBODY RESPONSE									
69	BLACKBODY RESPONSE						0	0	0	0
70	SENSOR LABEL									
71	0	0	DIGITAL SUN COUNT							
72	DIGITAL SUN COUNT									
73	DIGITAL SUN COUNT									
74	BET	EXT	0	ACQ	PRE	WDO PAR	SCN	RAT		
75	CALIBRATION FLAG									
76	DELTA BETA									
77	DELTA BETA									
78	DELTA BETA									
79	DELTA BETA									
80	SPARE									

CHART 8. MODE A IR DOCUMENTATION (Cont.)

MSB 1	2	3	4	5	6	7	8	9	LSB 10

Word	
81	SPARE
82	SPARE
.	.
.	.
.	.
98	SPARE
99	ORBIT & ATTITUDE 1
100	ORBIT & ATTITUDE 2
.	.
.	.
.	.
124	ORBIT & ATTITUDE 26
125	NORTH-SOUTH GRID OFFSET
126	EAST-WEST GRID OFFSET
127	CONFIGURATION CONTROL
128	LONGITUDINAL PARITY

TABLE 8. MODE A IR DOCUMENTATION

WORD NUMBER	CONTENTS	DESCRIPTION
1	Retrace	ONE (FE) indicates scanner retrace
2	Spacecraft Name (Binary)	Bits 3-6 S/C Number (Binary) Bits 7-8 P/DU Bits 9-10 VIP
3	Spacecraft Name BCD	Bits 3-6 MSD Bits 7-10 LSD
4	*Frame Code	ONE (FE) indicates VISSR or 3-Stage MSI picture transmission.
5	*Change Code	ONE (FE) indicates first line of VISSR or 3-Stage MSI picture if frame code is ONE or last line plus one of picture if frame code is ZERO (01).
6	*Step Code	ONE (FE) indicates normal VISSR or 3-Stage MSI line transmission; ZERO (01) indicates this line is not to be used to expose film and facsimile recorder line is not to be incremented (stepped).
7	SPARE	
8	IR Selection	Bits 1-7 Unused Bit 8 1 = Average (always 0)

* During VISSR and 3-Stage MSI Mode "A" Frame and Step Codes remain active (valid). However, during Dwell Soundings and 4-Stage MSI's Mode "A" Frame, Step, & Change Codes are invalid and set to ZERO (01)

CHART 8. MODE A IR DOCUMENTATION (Cont.)

WORD NUMBER	CONTENTS	DESCRIPTION
		Bit 9 1 = IR2 (always 0) Bit 10 1 = IR1 (always 1)
9	Gray Scale Status	ONE indicates gray scale information retransmission (always 01)
10	Direct Transmission Mode	ONE ($FE) indicates 28 Mb/sec ZERO ($01) indicates 14 Mb/sec
11-12	Image Count	Earth Count-See words 39-40 of Common Documentation, First Field. Word 11 2 most significant BCD characters Word 12 2 least significant BCD characters
13	Scan Mode	MODE A = FIXED $64
14-16	Beta Count	Word 14 Bit 3 = 0 Bits 4 - 10 7 MSBs Word 15 8 MID- Word 16 8 LSBs
17	Grid/No Grid	ONE ($FE) indicates grids ZERO ($01) indicates no grids

CHART 8. MODE A IR DOCUMENTATION (Cont.)

WORD NUMBER	CONTENTS	DESCRIPTION
18-19	PLL Error (Words 18 and 19 Common Documentation, First Field)	Word 18 Bit 3-10 (8 MSB's) Word 19 Bit 3-10 (8 LSB's)
20-21	Bit (Sync Word) Error Count	Word 20 Bits 3-10 (8 MSB's) Word 21 Bits 3-7 (5 LSB's) Word 21 Bits 8-10 Not Used
22	Setup Error	ONE ($FE) indicates a setup error (always $01)
23-24	Computer Error Message	Word 23 = Message 1 Bit 3 Not Used Bit 4 S/C - NESS Data Transfers Not Complete (always 0) Bit 5-8 Not Used Bit 9 "Execute" Output I/O Reject (always 0) Bit 10 Time-Input I/O Reject (always 0) Word 24 = Message 2 Bit 3 Beta Output I/O Reject (always 0) Bit 4 Mag Tape I/O Reject (always 0) Bit 5 NESS Reference I/O Reject (always 0) Bit 6-10 Not Used

CHART 8. MODE A IR DOCUMENTATION (Cont.)

WORD NUMBER	CONTENTS	DESCRIPTION	
25-26	SCAN COUNT (Same as Words Common Documentation, First Field)	BCD value split into 2 characters/ word	
		Word 25	2 most significant BCD characters
		Word 26	2 least significant BCD characters
27-34	Time - BCD	Word 27	Year - 2 MSD
		Word 28	Year - 2 LSD
		Word 29	Day of Year - 1 MSD (Bits 7-10)
		Word 30	Day of Year - 2 LSD
		Word 31	Hour
		Word 32	Minute
		Word 33	Second
		Word 34	Millisecond*10
35	Black Enable	ONE ($FE) indicates annotation transmission (always $01)	
36	Spare		
37	Bit/Frame Sync Lock Loss	Bit 10	1 = Any Loss
		Bit 9	1 = Bit Lock Loss (14MHz)
		Bit 8	1 = Frame Lock Loss
		Bit 7	1 = Bit Rate Loop Lock Loss
		Bit 3-6	Not Used

CHART 8. MODE A IR DOCUMENTATION (Cont.)

WORD NUMBER	CONTENTS	DESCRIPTION
38	Limited Scan Mode Indicator	ONE ($FE) indicates limited scan mode (always $01)
39	Sample Control	(LSB) IR-2PT (always 1) IR-1PT (always 0) IR-ET (always 0) Visible - 4PT (always 0) Visible - 2PT (always 1) Visible - 1PT (always 0) Visible - ET (always 0)
40	Not Used	
41	Scanner Direction	ONE ($FE) = North to South ZERO ($01) = South to North
42-45	Not Used	
46	Data Randomization	ONE indicates ON (always $FE)
47	Sun Pulse Select	ONE = Digital (always $FE)
48	NESS Mode Select	Bit 10 1 = MAX SV (always 0) Bit 9 1 = 4x2 IR (always 0) If bits 9, 10 are both zero, then 4x4 IR
49	IR2 Calibration Table Identifier	(always 0)

CHART 8. MODE A IR DOCUMENTATION (Cont.)

WORD NUMBER	CONTENTS	DESCRIPTION
50	Predicted Header	Scan Mode Single SCAN = 1 Normal SCAN = 2 Limited (variable) SCAN = 3 Small MSI (NOT USED) = 4 Large MSI (NOT USED) = 5
51	Bit Error	(always 0)
52	Mean IR Difference	(always 0)
53	RMS IR Difference	(always 0)
54-55	Correction Table Identification	Word 54 (8 MSB's) VIS Table ID (always 0) Word 55 (8 LSB's) IR1 Table ID (always 0)
56-57	Left Horizon Point	Word 56 = 8 MSB's (In units of IR1 Word 57 = 8 LSB's samples only.)
58-59	Right Horizon Point	Word 58 = 8 MSB's (In units of IR1 Word 59 = 8 LSB's samples only.)
60-61	Equatorial Scan Count (Binary)	Word 60 = 8 MSB's Word 61 = 8 LSB's
62-65	Beta Dot	Fixed at 15 degrees per hour - HEXADECIMAL VALUE = 2E978D50
66-67	Elevation Angle	Word 66 = 8 MSB's (always $1C) Word 67 = 8 LSB's (always $78)

O-3822
84-324

CHART 8. MODE A IR DOCUMENTATION (Cont.)

WORD NUMBER	CONTENTS	DESCRIPTION
68-70	Blackbody Response	SHUTTER RADIANCE AVERAGE for IR 1 (see Common Documentation third field, word 13 & 14--multiplied by 2^{11}) Word 68 Bits 3-10 Integer Word 69 Bits 3-6 Fraction Bits 7-10 Spare Word 70 Sensor used for this scan 1 = small HgCdTe 2 = large HgCdTe 3 = large InSb
71-73	Digital Sun Count	Always 0
74	Input Bits	Bit 10 1 = Scan Rate Rapid Bit 9 1 = Scan Step On Bit 8 1 = Word 0 Parity Error Bit 7 1 = Precess Mode (always 0) Bit 6 1 = Digital Acquisition (always 1) Bit 5 Not Used Bit 4 1 = Extended Scanner (always 0) Bit 3 1 = Linear Beta (always 0)
75	Calibration Flag	1 = IR data calibrated 0 = IR data not calibrated (1:1 transfer)
76-79	Delta Beta	Local correction of grids E-W. (always 0)

CHART 8. MODE A IR DOCUMENTATION (Cont.)

WORD NUMBER	CONTENTS	DESCRIPTION
80-98	Spares	
99-124	Orbit & Attitude Data	Same as common documentation field 1, words 99-124.
125	North-South Grid Offset	(always 0)
126	East-West Grid Offset	(always 0)
127	Configuration Control	(always 2)
128	Parity Word	An exclusive-OR of each corresponding bit of all pre-ceeding 127 words. The result is then complemented so ~~that~~ the resultant longitudinal parity is odd.

3.3.3.7 Spare

The spare section contains 384 words intended for future processor load information and orbit and attitude data.

3.3.3.8 Error Check Field.

See 3.3.2.1.

3.3.3.9 Unused.

This section contains 3586 words to be used in future expansion.

3.3.4 Blocks 4 Through 11.

The contents of the information fields of the Visible Blocks (blocks four through 11) will normally be data from the eight visible sensors, each block dedicated to a particular sensor. In addition the video data in each block (15288 words) is preceeded by 512 documentation words.

The format of the information field is shown diagrammatically in Figure 7.

All unused, unspecified, or spare words will be assumed to be set to $00. The use of the sign ($) signifies hexadecimal notation. All unused, unspecified, or spare bits will be set to zero.

3.3.4.1 Visible Documentation

The documentation part of the visible information field is 512 six-bit words long. Only six of the documentation words presently contain information, the remaining words are reserved for future use.

The organization and description of the contents of the visible documentation is shown in Chart 9 and Table 9 below.

NOTE: The VIP generates words 1 to 8 of the VIS DOC.
The P/DU fills in spare words 9-512.

3.3.4.2 Error Check Field

See 3.3.2.1.

VISIBLE DOC.	VISIBLE VIDEO	FCS

FIGURE 7 - VISIBLE BLOCK INFORMATION FIELD

CHART 9. VISIBLE DOCUMENTATION

Word	MSB 1	2	3	4	5	LSB 6	
1							
2	SECTOR CODE						VIP
3							
4	FRAME CODE						VIP
5	CHANGE CODE						VIP
6	STEP CODE						VIP
7	SPARE						VIP
8	SPARE						VIP
9	SIGN	EARTH COUNT					P/DU
10	EARTH COUNT						P/DU
11	SIGN	PREDICTED SCAN COUNT					P/DU
12	PREDICTED SCAN COUNT						P/DU
.	SPARE						P/DU
.	SPARE						P/DU
.	SPARE						P/DU
512	SPARE						P/DU

TABLE 9. VISIBLE DOCUMENTATION

WORD NUMBER	CONTENTS	DESCRIPTION
1-3	Sector Code*	The code used three words; each word represents a logic zero or logic one state. (Example: Sector 5 is identified as 111110 000001 111110). The most significant word is first, the sectors containing visible data have numbers: 000, 001...111. The correspondence between block number, sector, and visible line number is as follows:

Block	Sector	VIS Line
4	0	1
5	1	2
6	2	3
7	3	4
8	4	5
9	5	6
10	6	7
11	7	8

WORD NUMBER	CONTENTS	DESCRIPTION
4	Frame Code*	ONE indicates picture transmission
5	Change Code*	ONE indicates start of picture if frame code is ONE or end of picture if frame code is ZERO.

TABLE 9. VISIBLE DOCUMENTATION (Cont.)

WORD NUMBER	CONTENTS	DESCRIPTION
6	Step Code*	ONE indicates normal line transmission; ZERO indicates this is not to be used to expose film and facsimile recorder line is not to be incremented (stepped).
7-8	Spares	
9-10	Earth Count	Word 9 Bit 1 = 0 Positive
		Bit 1 = 0 Negative
		Word 9 Bits 2-6 MSBs
	(Binary)	Word 10 Bits 1-6 LSBs
11-12	Predicted	Word 11 Bit 1 = 0 Positive
	Scan Count	Bit 1 = 1 Negative
	(Binary)	Word 11 Bits 2-6 MSBs
		Word 12 Bits 1-6 LSBs
13-512	Spares	

*All but the last bit in each code word are identical, e.g., 000001 (ZERO) or 111110 (ONE).

APPENDIX A - USER CALIBRATION OF IR DATA

The VAS calibration using general notation is expressed in the following equation:

$$R(T_t) = \frac{V_t \quad V_z}{V_{bb} - V_z} \{R(T_{bb}) + \Sigma\, c_i\, [R(T_{bb}) - R(T_i)]\}$$

where

$$R(T) = \frac{\int_0^\infty SR(\nu)B(\nu,T)d\nu}{\int_0^\infty SR(\nu)d\nu},$$

and R represent the radiance, V the detector voltage, c the calibration coefficients, SR the spectral response function, B the Planck function, T the temperature, and ν the wavenumber. The subscript t stands for earth target, z for space, bb for internal blackbody, and i for the telescope foreoptics components that contribute to the background radiation. The term in the brackets {} represents the effective blackbody radiance corrected for telescope foreoptics contribution to the background radiation. This calibration strategy assumes that SR is known and fixed. For the VAS calibration calculation, R(T) is curve fit to a cubic polynomial function of temperature.

If SR varies, as it will with a floating filter wheel temperature, an additional correction term must be included

$$\Delta R(T,T_{FW}) = \left.\frac{dB(T)}{d\nu}\right|_{\nu=\nu_c} \frac{d\nu_c}{\partial T_{FW}} (T_{FW} - T_{FW}^{nom})$$

where ν_c is the center wavenumber for the spectral band and T_{FW}^{nom} is the nominal filter wheel temperature for which the spectral response functions have been determined (usually 40°C).

We can then write the corrected radiance,

$$R'(T) = R(T) + \Delta R(T,T_{FW}) .$$

The target radiance is a 32 bit floating point number that is scaled to fit into the output format through the use of equations for a particular spacecraft and filter/detector combination. These equations have the form of Ax-B, where the offsets account for radiation from the foreoptics and other effects, and the slopes yield a mean radiance of approximately 500 for each filter/detector combination. There are 38 sets of coefficients supplied to the VIP in the IR calibration data. These coefficients are documented, every spin, in the Common Documentation of the output data.

In the notation of the AAA Common Documentation, the seven steps in the calibration scheme are:

(i) Calculate the temperature of VAS telecope foreoptics components and the filter wheel from digital thermistor readings Si and the 15 volt auxiliary power supply AV

$$Ti = \sum_{j=0}^{3} Ai(j)*(Si/AV)**j$$

where i is the component index documented on page 69 and the Ai(j) are determined from curve fitting.

(ii) Extract radiance of telescope components for the 38 different spectral band-detector combinations.

$$Rk(Ti) = \sum_{j=0}^{3} Ck(j)*(Ti/64)**j$$

where k is the band-detector index documented in Table 5C1, and the Ck(j) come from polynomial fits of the radiance integrated over spectral response. Only 19 of the Ck's are transmitted to the VIP. To get the correct Ck's for the other 19, use the table on page 74. Rk(T11) need not be calculated.

(iii) Correct for spectral shifts due to filter wheel temperature excursions.

$$R'k(Ti) = Rk(Ti) + \Delta Rk(Ti,T11)$$

where $\Delta Rk(Ti,T11) = (T11-Tfw)* \sum_{j=0}^{3} Ek(j)*Ti**j$

and Tfw, the nominal filter wheel temperature, is documented in the IR calibration parameter data set. Also 19 of the 38 possible Ek's are documented in the IR calibration parameter data set. To get the correct Ek's for the other 19, use the table on page 74.

(iv) Use the calibration algorithm to determine an equivalent blackbody radiance for the band-detector combination in use.

$$R'k(Teb) = R'k(Tbb) + \sum_{i=1,2,3,7,9,10} Mi*(R'k(Tbb) = R'k(Ti)) \;.$$

$$+ \sum_{i=4,8} Wk(i)*(R'k(Tbb) - R'k(Ti))$$

where $R'k(Tbb) = (R'k(T5) + R'k(T6))/2$

Only 12 of the W4's and 12 of the W8's are documented in the IR calibration parameter set. Only spectral band dependence is assumed. To get the correct values for the other 26, use Table 5C1.

(v) Correct the detector response for detector nonlinearities to generate a computed signal X for space, target, and internal blackbody view.

$$X_{km} = \sum_{j=0}^{3} Gk(j) * (Dkm/1024) ** j$$

where m = z represents Space look and Dkz in space counts.
m = bb represents the Blackbody look and is Dkbb in shutter counts,
m = t represents target (Earth) look and Dkt is target counts.

Only 16 of the 38 Gk's are documented in the IR calibration parameter data set. To get the correct values for the other 22, use the table on page 79.

(vi) Calculate the target radiance.

$$RADk(Tt) = R'k(Teb)*(Xkt - Xkz)/(Xkbb - Xkz)$$

(vii) Calculate the pixel value, IP, to be retransmitted.

$$IP = (RADk(Tt) + ABk(0))/ABk(1) + 0.5$$

where the ABk(i) are documented in the IR calibration parameter data set. The 0.5 is added so the pixel values are rounded rather than truncated integers.

Upon receipt of the data, it is left for the user to correct pixel values to radiances by inverting step vii. Thus the Mode AAA user must calculate:

$$RADk(Tt) = ABk(1) * IP - ABk(0)$$

Note that the coefficients ABk(i) must be restored to their unscaled values in the above equation, as follows:

$$ABk(i)_{unscaled} = ABk(i)_{scaled}/2^{(15 - FAB_k)}$$

Frame, Step, and PDL Lock Codes

The frame and step codes are used in all four types of pictures: Single Scan, Normal, Variable, and Processor On. The PDL lock code is used only in the Processor On case. The setting and clearing of these picture codes is described as follows:

I. Single Scan -

The frame and step codes are set whenever a frame start command is received. They are both cleared when a frame stop command is received.

II. Normal -

The frame code is set when the scan count increments by one three times and during these three scans there is no more than one word zero parity error. Once the frame code is set, the step code is set only on scans 3, 4, and 5, and on scans between Equat -836 and Equat +836 inclusive. Once the scanner passes the scan line equal to Equat +836, both the frame and step codes are cleared.

III. Variable -

The frame code is set whenever the scan line is between or equal to the variable frame start and variable frame end lines. The frame code is cleared on all other lines.

The step code is set whenever the scanner is between or equal to the variable frame start and end lines and when the scanner is moving toward the variable frame end line. The step code is cleared at all other times, such as when the scanner is retracing or when it is outside of these limits.

IV. Processor On

The frame and step codes are only set if the scan count is between the frame start and stop lines inclusive and under the following condition.

The frame and step codes are set whenever the step scan flag is on in either the header or word zero for at least two out of three spins and when a large amount of the PDL syncs cannot be found. The step scan flag in the header is checked if there is not a sync error on this flag, otherwise word zero is checked if there is no word zero parity errors. If both the header and word zero are in error then the step scan flag is considered to be off. The large amount of PDL sync errors indicates that the VIP is receiving IR data rather than the verification data.

Once the frame code has been set, the PDL lock code is set initially as follows:

1) If the picture begins at the frame start line and there are calibration spins then the PDL lock code is set after receiving two out of three headers which agree with the predicted header during the calibration spins.

2) If there are no calibration spins or if the picture begins in the middle then the PDL lock code is set if one of the first two scan lines has no header data errors.

If the PDL lock code cannot be set initially as in steps 1 or 2 then it is set as follows:

1) MSI Picture -

The PDL lock code is set after receiving 4 consecutive headers which agree with the predicted headers.

2) Dwell Sound -

The PDL lock code is set once the VIP knows which submode is being executed. This will take at least 2 submodes and maybe 3.

Once the PDL lock is set a counter is initialized to five. When a header data error occurs this counter is decremented, otherwise it is incremented. The counter may not exceed 5. Once the counter reaches zero, the PDL lock is cleared and is only reset when one of the above conditions for either an MSI or Dwell Sound picture is met.

The PDL lock code is also cleared at the end of the picture when the frame and step codes are cleared.

For all of the above pictures when the frame code is set it means that the VIP is receiving valid data. When the step code is set it indicates that the data which the VIP Is processing may be recorded on a film recorder.

In the case of the processor on picture, the PDL lock code indicates that the VIP is synchronized with the PDL execution and therefore the data is being calibrated correctly. When the PDL lock code is not set then either the VIP is not synchronized with the PDL execution or there is a problem in the transmission of the data. Only when the PDL lock code is set can one be sure that the data is being calibrated correctly.

Earth Count

The Earth Count is a numbering system mapped onto the earth disk, where line 836 always passes through the center of the earth. The predicted scan count is mapped into this numbering system via the following equation:

$$\text{Earth Count} = \text{Predicted Scan Count} - \text{EQUAT} + 836$$

where:

EQUAT is derived from the equatorial coefficients contained in the Orbit and Attitude data base.

If the satellite is positioned such that the mirror will scan the equator on scan line 836, then the predicted scan line will equal the earth count throughout the entire picture. However, if the satellite will scan the equator at some scan line other than 836, then the earth count will differ from the predicted scan count by a fixed constant (EQUAT-836) for the entire picture.

This numbering system will ensure that separate pictures will map on top of each other, if the earth count is used in place of the predicted scan count. The earth count numbering system will only correct for North/South shifts. Some examples showing the documentation data output sequence, from frame-to-frame for the VAS instrument, are provided on the following pages.

*VAS—VISSR MODE

VAS DOCUMENTATION DATA

FRAME CODE	CHANGE CODE	STEP CODE	MODE A STEP CD	SCAN COUNT	EARTH COUNT
01	01	01	01	0001	0000
01	01	01	01	0001	0000
FE	FE	FE	01	0001	0000
FE	01	FE	01	0002	0000
FE	01	FE	01	003N	0000
FE	01	FE	01	0039	0000
FE	01	FE	FE	0040	0001
FE	01	FE	FE	0041	0002
FE	01	FE	FE	0501	0462
FE	01	FE	FE	181X	177Y
FE	01	FE	FE	1820	1781
FE	01	FE	FE	1821	1782
01	FE	01	01	1821	1782
01	01	01	01	1821	1782

* MODE A DOCUMENTATION FRAME AND CHANGE CODE IS EQUIVALENT TO COMMON DOCUMENTATION IN VISSR MODE

**VAS-MSI

VAS DOCUMENTATION DATA

FRAME CODE	CHANGE CODE	STEP CODE	MODE A STEP CD	SCAN COUNT	EARTH COUNT
01	01	01	01	0101	0060
01	01	01	01	0101	0060
FE	FE	FE	01	0101	0060
*FE	01	FE	01	0101C	0060
*FE	01	FE	01	0101C	0060
*FE	01	FE	01	0101C	0060
FE	01	FE	FE	0102	0061
FE	01	FE	FE	0103	0062
FE	01	FE	FE	054X	049Y
FE	01	FE	FE	15XX	14XY
FE	01	FE	FE	1500	1460
FE	01	FE	FE	1501	1461
01	FE	01	01	1501	1461
01	01	01	01	1501	1461

* NOTE: 12 CALIBRATION SPINS IF ENABLED

** MODE A DOCUMENTATION FRAME AND CHANGE CODE IS EQUIVALENT TO COMMON DOCUMENTATION IN VAS-MSI

VAS–DS

VAS DOCUMENTATION DATA

FRAME CODE	CHANGE CODE	STEP CODE	MODE A DOCUMENTATION FRAME	MODE A DOCUMENTATION CHANGE	MODE A DOCUMENTATION STEP	SCAN COUNT	EARTH COUNT
01	01	01	01	01	01	0228	0199
01	01	01	01	01	01	0228	0199
FE	FE	FE	01	01	01	0228	0199
*FE	01	FE	01	01	01	0228C	0199
*FE	01	FE	01	01	01	0228C	0199
*FE	01	FE	01	01	01	0228C	0199
FE	01	FE	01	01	01	0229	0200
FE	01	FE	01	01	01	0230	0201
FE	01	FE	01	01	01	038X	035Y
FE	01	FE	01	01	01	0382	0353
FE	01	FE	01	01	01	0388	0361
01	FE	01	01	01	01	0388	0361
01	01	01	01	01	01	0388	0361

* NOTE: 12 CALIBRATION SPINS IF ENABLED

APPENDIX C - EARTH LOCATION EQUATIONS

1.0 GENERAL

The objective of this algorithm is to compute the line and element of the VAS corresponding to a given point on the surface of the earth. The algorithm can be divided into five parts:

1) Earth point-involves computation of a vector $\bar{R}$ from the earth center to a point specified by a latitude and longitude.

2) Satellite position-involves computing the satellite position vector $\bar{P}$ from the earth center.

3) View vector — the earth point view vector $\bar{V}$, from the satellite position is computed in satellite coordinates.

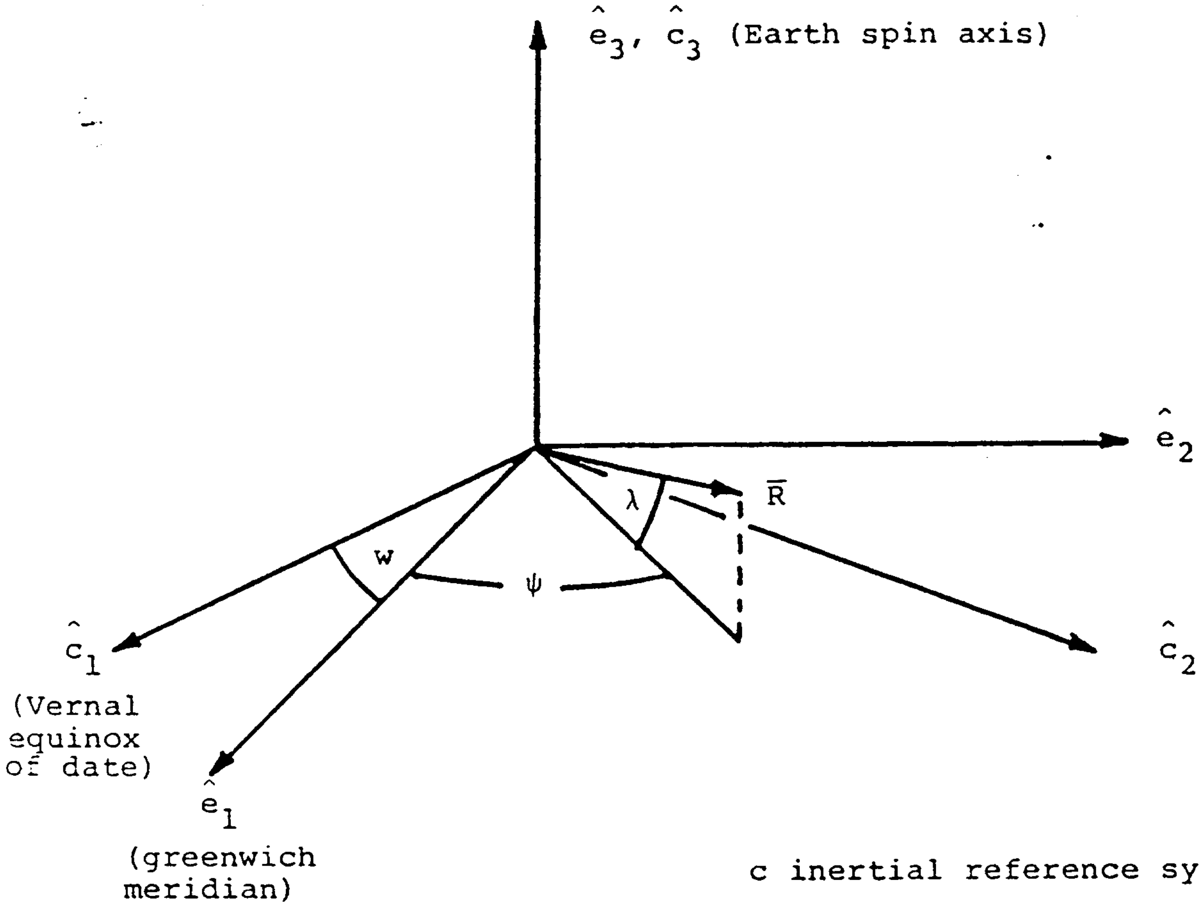
4) Line;element — The location of the VISSR line and element is computed from $\bar{V}$ and VAS orientation parameters.

5) Time — The predicted time at which the specified line and element is computed iteratively based upon frame start time.

This note is based upon the paper, "Earth Location Equations" prepared for NASA/Goddard by Westinghouse Electric Corporation (revised July 20, 1977) under contract NAS 5-23583.

2.0 EARTH POINT

The coordinate systems required are shown in Figure 1. We start with the geodetic latitude λ' and the longitude Ψ. The earth is taken to be an oblate spheroid with equatorial radius a = 6378.144 km and polar radius b = 6356.759 km. Consider the intersection of the earth and a plane thru meridian Ψ as shown in Figure 2. The geocentric latitude is computed from the geodetic latitude from equation (1). The earth radius is then computed from equation (2). The total length of



c inertial reference system

e earth reference system

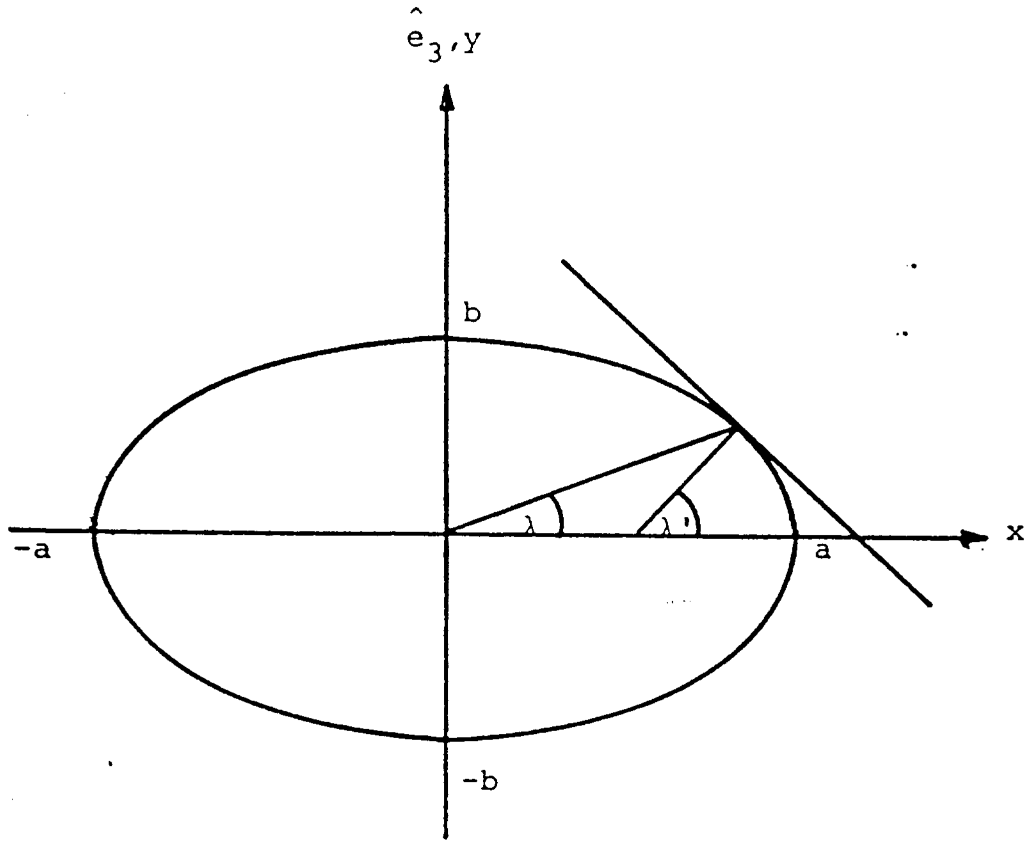
λ geocentric latitude

ψ east longitude

$\bar{R}$ vector from earth center to surface at λ, ψ

w earth spin angle ($w=90^{\circ}$ when $\hat{e}_1 = \hat{c}_2$

Figure 1



λ geocentric latitude

λ' geodetic latitude

r earth radius

$$\frac{x^2}{a^2} + \frac{y^2}{b^2} = 1$$

$$\tan \lambda = \frac{b^2}{a^2} \tan \lambda' \qquad (1)$$

$$r = \frac{a}{\left[1 + \varepsilon \sin^2 \lambda\right]^{\frac{1}{2}}} \qquad \varepsilon = \frac{a^2 - b^2}{b^2} \qquad (2)$$

$$|\bar{R}| = r \qquad (3)$$

Figure 2. Latitude Relations

$$\bar{R}_E = r \begin{bmatrix} \cos\lambda \cos\psi \\ \cos\lambda \sin\psi \\ \sin\lambda \end{bmatrix}$$

Expressed in the inertial coordinate system we have

$$\bar{R}_C = r \begin{bmatrix} \cos\lambda \cos(\psi+w) \\ \cos\lambda \sin(\psi+w) \\ \sin\lambda \end{bmatrix}$$

where w is the earth rotation angle at time t at which the VISSR scans the desired earth point. Time will be normalized for a period starting at epoch, t_e (DATE1 + TIME1; see Appendix A pages 26 and 27) and ending at epoch plus D(D=13 hours). Then normalized time u is:

$$u = \frac{2\,(t-t_e)}{D} - 1 \qquad \text{(4a)}$$

(Note that all unnormalized times t, t_e and D must be in the same units.)

The angle w is then:

$$w = \frac{1}{2}\,(w_2 + w_1 + (w_2 - w_1)\ u) \qquad \text{(4b)}$$

where w_1 = GRA1 and w_2 = GRA2; see Appendix.

3.0 SATELLITE POSITION

The satellite position, in the inertial coordinate system, will be computed from three Chebychev polynomials -- one per dimension. Each polynomial will have 11 parameters CXI, CYI or CZI; see Appendix A.

Thus for any direction we have:

$$P = \sum_{i=0}^{10} C_i\ T_i\ (u) \qquad \text{(5a)}$$

where C_i = CXI, CYI or CZI

$$T_o\ (u) = 1$$
$$T_1\ (u) = u$$
$$T_n\ (u) = 2u\ T_{n-1}\ (u) - T_{n-2}\ (u) \text{ for } n \geq 2$$

and the prime on the summation indicates that the term C_o should be multiplied by 1/2.

If we now define:

$$b_i(u) = 2u\, b_{i+1}(u) - b_{i+2}(u) + C_i \quad \text{for } i=0, \ldots, 10$$

$$b_{11}(u) = b_{12}(u) = 0$$

Then

$$P = \frac{1}{2}\left(b_o(u) - b_2(u)\right) \tag{5b}$$

4.0 VIEW VECTOR

The vector $\overline{V}$ from the satellite to the earth point, in inertial coordinates, is:

$$\overline{V}_c = \overline{R}_c - \overline{P}_c \tag{6}$$

We wish to express vector $\overline{V}$ in a satellite coordinate system. One component ($\hat{S}_3$) of the desired coordinate system is the satellite spin vector. The direction of this vector in inertial coordinates, see Figure 3, is given by:

$$\delta = \frac{1}{2}\left[\delta_2 + \delta_1 + (\delta_2 - \delta_1)\, u\right] \tag{7a}$$

$$\alpha = \frac{1}{2}\left[\alpha_2 + \alpha_1 + (\alpha_2 - \alpha_1)\, u\right] \tag{7b}$$

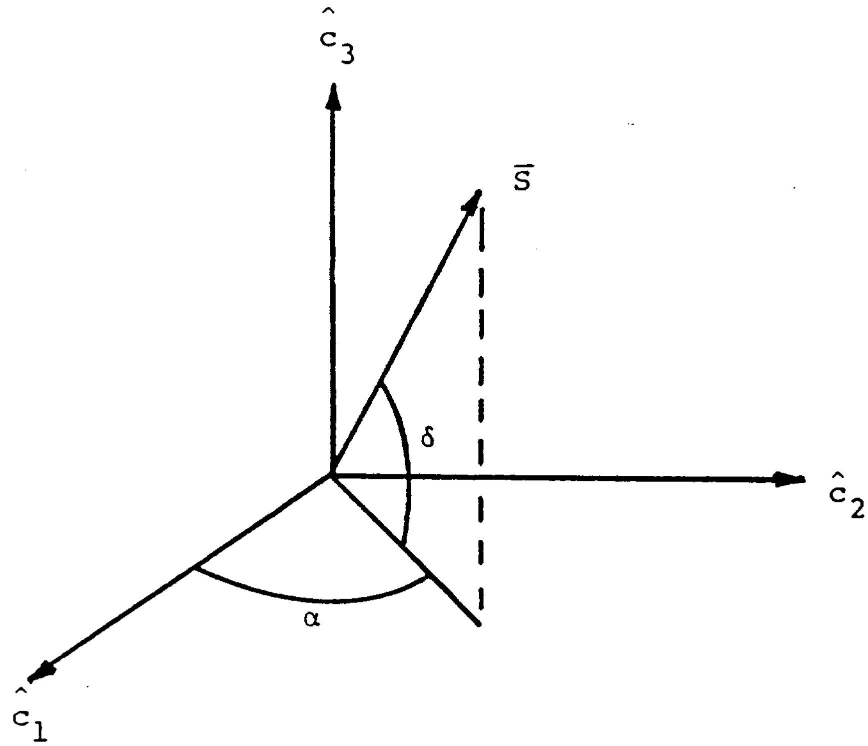
where δ_1 = SPDC1, δ_2 = SPDC2, α_1 = SPRA1 and α_2 = SPRA2; see Appendix.

Then

$$\overline{S} = \begin{bmatrix} \cos\delta \cos\alpha \\ \cos\delta \sin\alpha \\ \sin\delta \end{bmatrix} = \hat{S}_3 \tag{8}$$

The direction of the other two components of the satellite coordinate system are now defined. We define $\hat{S}_1$ as the unit vector in a plane orthogonal to $\hat{S}_3$ which is aligned with the negative projection of the $\overline{P}$ vector in this plane. Then, as shown in Figure 4:

$$\hat{S}_1 = \frac{-\overline{P} + (\overline{P}\cdot\overline{S})\,\overline{S}}{\sqrt{P^2 - (\overline{P}\cdot\overline{S})^2}} \quad \text{where } \overline{P}\cdot\overline{S} = P_1S_1 + P_2S_2 + P_3S_3 \tag{9}$$



$\overline{S}$ vector representing spin axis

δ declination of $\overline{S}$ ($\delta=90^{\circ}$ and $\alpha=0^{\circ}$ when $\overline{S}=\hat{C}_3$)

α right ascension of $\overline{S}$ ($\alpha=90^{\circ}$ when projection is along $\hat{C}_2$)

Figure 3. Spin Vector

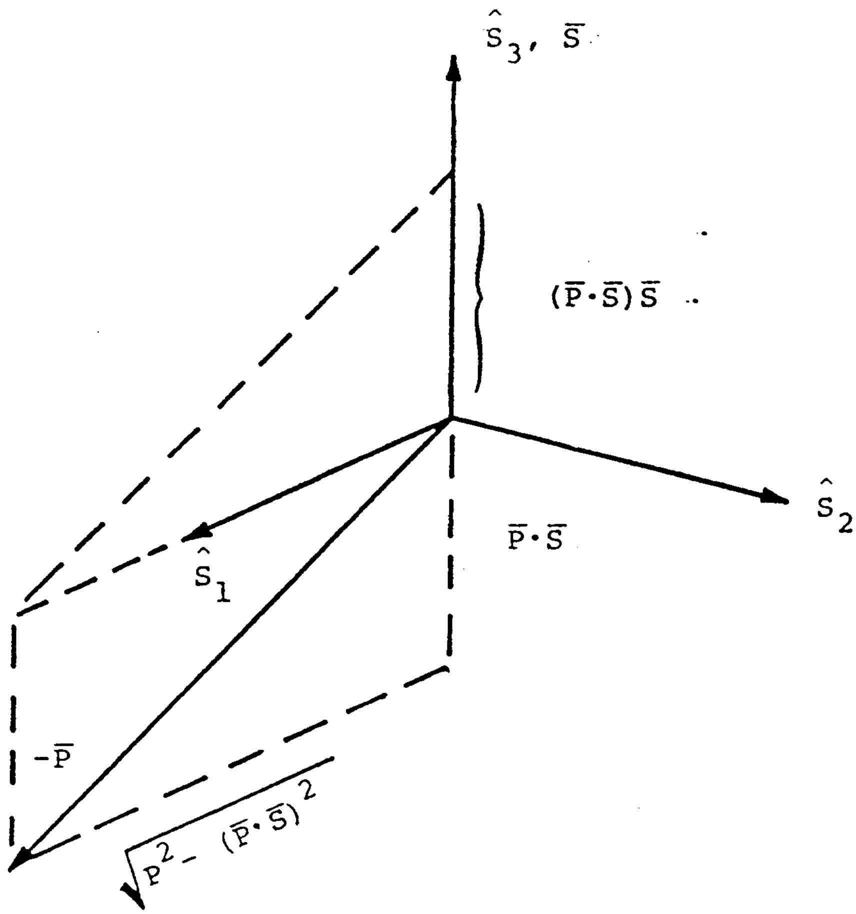


Figure 4. Satellite Coordinate System

The denominator is the length of the vector defined by the numerator. Then:

$$\hat{S}_2 = \hat{S}_3 \times \hat{S}_1 \text{ , where AXB} = \begin{bmatrix} a_2b_3 - a_3b_2 \\ a_3b_1 - a_1b_3 \\ a_1b_2 - a_2b_1 \end{bmatrix} \tag{10}$$

Thus we have obtained three unit orthogonal vectors $\hat{S}_1$, $\hat{S}_2$, $\hat{S}_3$ each of which is defined in the inertial system. To find the components of $\overline{V}$ in the $\hat{S}$ system we can form:

$$\overline{V}_s = \begin{bmatrix} \hat{S}_1{}^T \\ \hat{S}_2{}^T \\ \hat{S}_3{}^T \end{bmatrix} \overline{V}_c \tag{11}$$

where T denotes transpose.

5.0 LINE AND ELEMENT

To define a coordinate system fixed in the rotating spacecraft, we should define a reference line fixed in the spacecraft. We define that reference as the projection of the sun sensor FOV into the spin plane for the actual sun elevation. Thus, we note that this reference line is not actually fixed in the spacecraft since it will generally vary with the sun elevation and the spin vector orientation relative to the sun sensor. This reference has been selected since it corresponds to the actual sun pulse produced by the spacecraft. Figure 5 shows this reference denoted as $\hat{J}$ at an angle of $\gamma+\theta$ from $\hat{S}_1$. The unit vector $\hat{S}_1'$ represents the predicted location of the intersection of the VISSR FOV plane and the spin plane and is at an angle γ from $\hat{J}$. The azimuth angle θ is between the earth oriented unit vector $\hat{S}_1$ and the rotating spacecraft vector $\hat{S}_1'$. The angle γ is based upon the best available data from landmark or other measurements made prior to the actual VISSR data acquisition.

Then, using this angle γ (see section 7), we may note that each earth image as produced by the synchronizer-data buffer (S/DB) is not precisely centered in the east-west (spin plane) direction. Thus the data implies that the actual VISSR FOV plane has shifted by an angle we call element bias and designate as ρ. This angle includes all residual terms in the spin plane due to factors such as measurement errors or shifts in the VISSR or sun sensor mounting and relative delays of signals in the spacecraft and ground station not accounted for by the angle γ. Since such residual errors are not predictable the S/DB documented value for this term will normally be zero; see Appendix A.

In general the VISSR FOV plane does not contain the spin vector $\hat{S}_3''$. We can define a unit vector $\hat{S}_3'''$ which is coincident with the projection of $\hat{S}_3''$ into the VISSR FOV plane; see Figure 6. The angle between $\hat{S}_3''$ and $\hat{S}_3'''$ is denoted by η and called the skew bias.

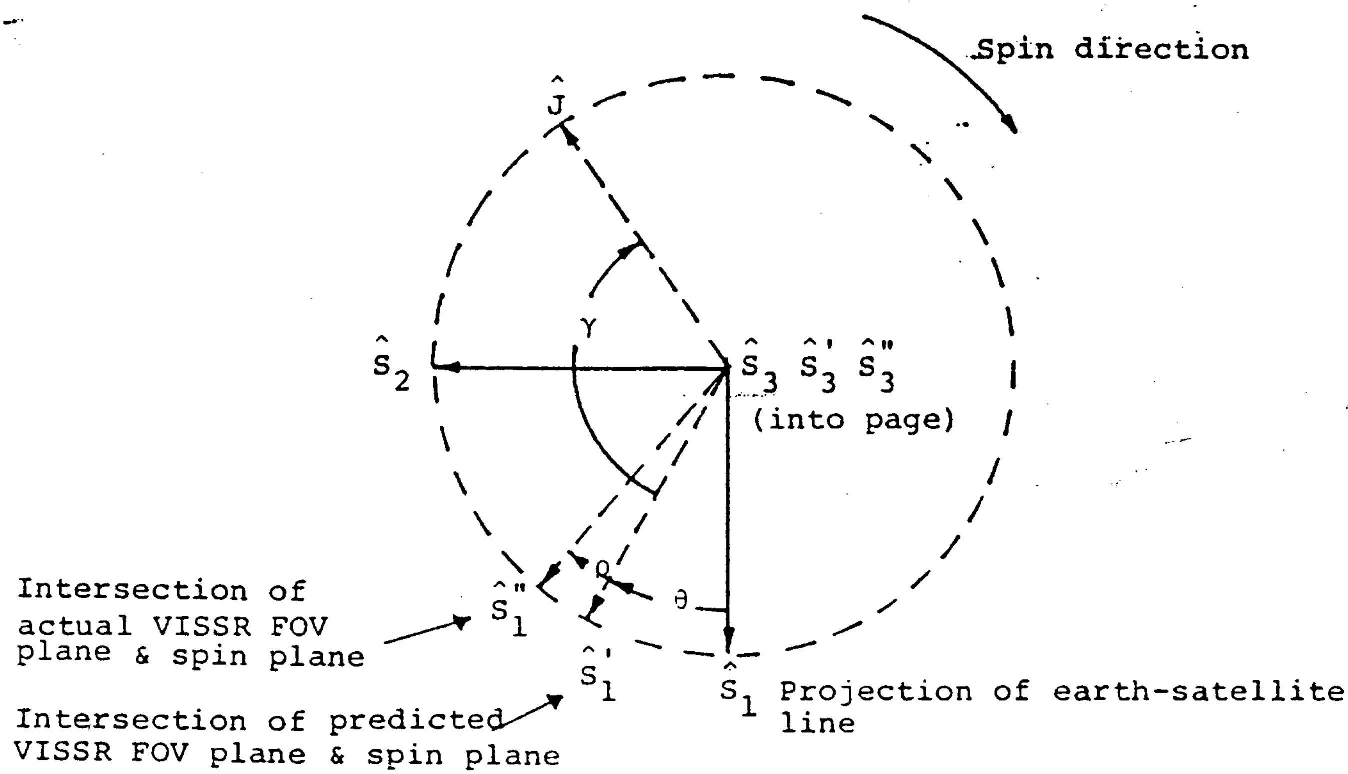
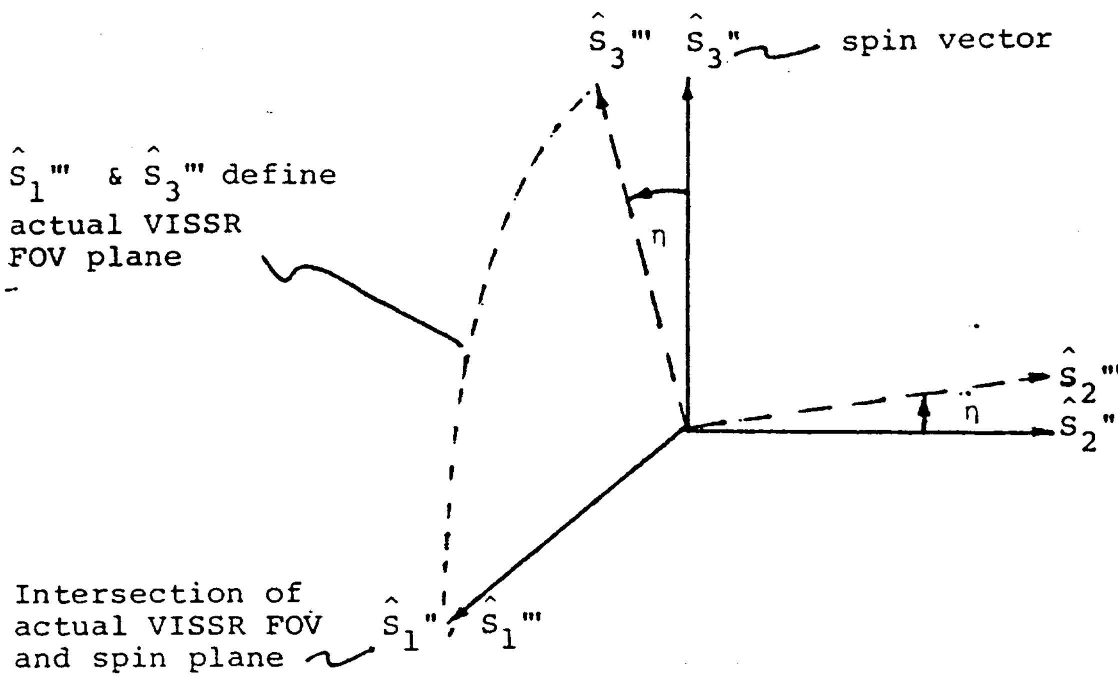
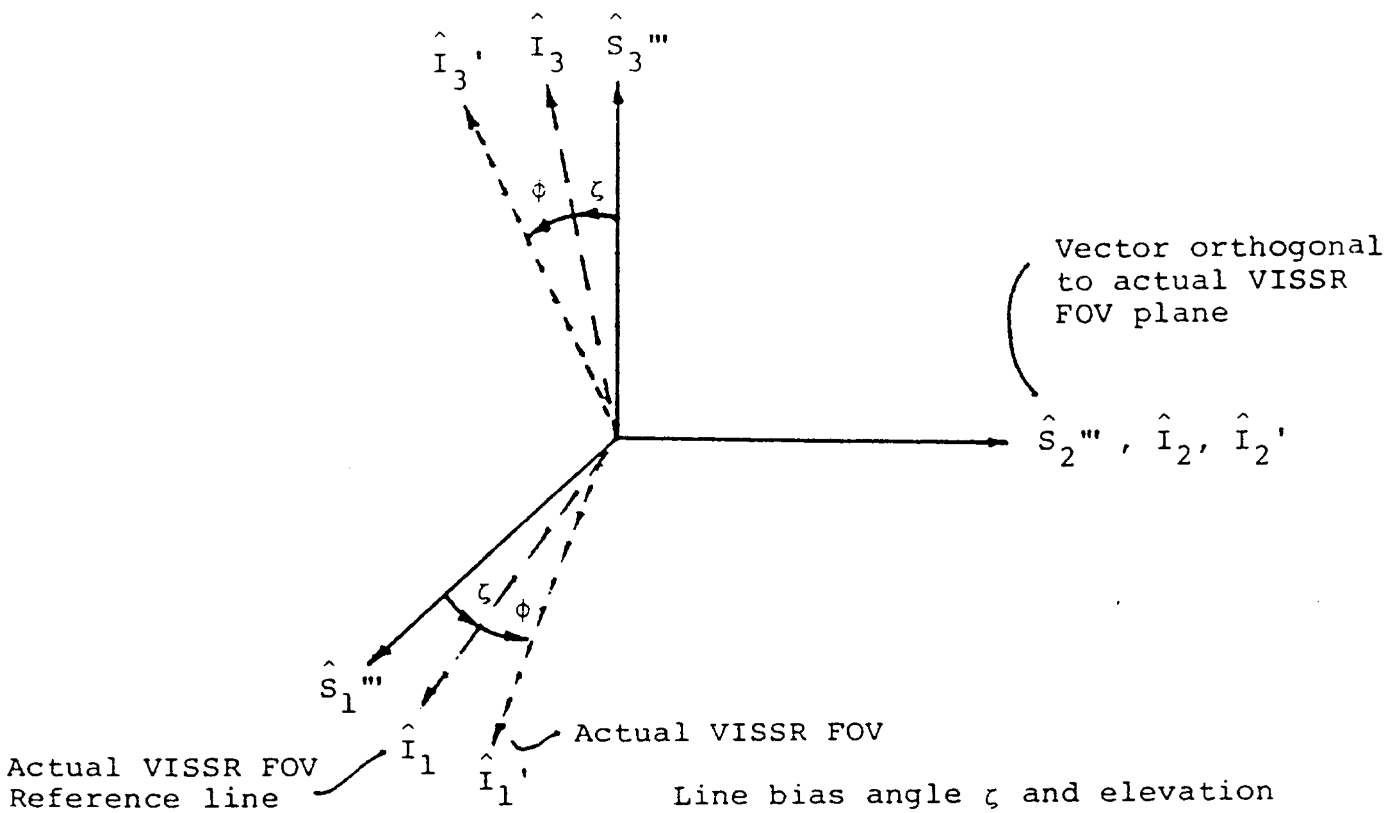


Figure 5. Spacecraft Reference Line



Skew bias angle η



Line bias angle ζ and elevation angle ϕ

Figure 6. VISSR Coordinate System

As a result of VISSR mirror stepping, the actual VISSR FOV usually moves between the normal north limit (scan count = 1) and the normal south limit (scan count = 1821). (There is also an expanded scanning mode in which both limits can be exceeded.) The actual VISSR FOV reference line $\hat{I}_1$ is defined as corresponding to the actual FOV at a scan count of 911. The angle between the reference line $\hat{I}_1$ and intersection of the actual VISSR FOV and the spin plane $\hat{S}_1'''$ is called the line bias and denoted by ζ.

Finally the actual VISSR FOV line, represented by unit vector $\hat{I}_1'$, is at some elevation angle ϕ from $\hat{I}_1$. Note that this angle is positive if the earth point is north of the spin plane.

We may now proceed to express the view vector $\bar{V}_S$ in the VISSR coordinate system $\hat{I}'$. We obtain:

$$\bar{V}_S'' = \begin{bmatrix} \cos(\theta+\rho) & \sin(\theta+\rho) & 0 \\ -\sin(\theta+\rho) & \cos(\theta+\rho) & 0 \\ 0 & 0 & 1 \end{bmatrix} \bar{V}_S \qquad (12)$$

$$\bar{V}_S''' = \begin{bmatrix} 1 & 0 & 0 \\ 0 & \cos\eta & \sin\eta \\ 0 & -\sin\eta & \cos\eta \end{bmatrix} \bar{V}_S'' \qquad (13)$$

$$\bar{V}_I' = \begin{bmatrix} \cos(\zeta+\phi) & 0 & -\sin(\zeta+\phi) \\ 0 & 1 & 0 \\ \sin(\zeta+\phi) & 0 & \cos(\zeta+\phi) \end{bmatrix} \bar{V}_S''' \qquad (14)$$

The vector $\bar{V}$ in the image coordinate system is constrained to lie in the $\hat{I}_1\hat{I}_3$ plane. Therefore $V_{I_2} = 0 = V_{S_2}'''$

$$V_{S_2}''' = V_{S_2}'' \cos\eta + V_{S_3}'' \sin\eta = 0$$

$$V_{S_3}'' = V_{S_3}; \; V_{S_2}'' = -V_{S_3} \tan\eta \qquad (15a)$$

$$V_{S_2}'' = -V_{S_1} \sin(\theta+\rho) + V_{S_2} \cos(\theta+\rho)$$

Then:

$$V_{S_3} \tan\eta = V_{S_1} \sin(\theta+\rho) - V_{S_2} \cos(\theta+\rho) \tag{15b}$$

In equation (15) all the quantities except θ are known. We may solve this equation by first defining:

$$\sigma = \arctan\left(\frac{V_{S_2}}{V_{S_1}}\right) \tag{16}$$

Then:

$$V_{S_2} = \sqrt{V_{S_1}^{\ 2} + V_{S_2}^{\ 2}} \sin\sigma$$

$$V_{S_1} = \sqrt{V_{S_1}^{\ 2} + V_{S_2}^{\ 2}} \cos\sigma$$

and

$$\frac{V_{S_3} \tan\eta}{\sqrt{V_{S_1}^{\ 2} + V_{S_2}^{\ 2}}} = \cos\sigma \sin(\theta+\rho) - \sin\sigma \cos(\theta+\rho)$$

$$= \sin(\theta+\rho-\sigma) \triangleq \sin\xi \tag{17}$$

To avoid the need for an arcsin routine, we may write ξ as:

$$\xi = \arctan\left(\frac{V_{S_3} \tan\eta}{\sqrt{V_{S_1}^2 + V_{S_2}^2 - V_{S_3}^2 \tan^2\eta}}\right) \tag{18}$$

Then: $\theta = \xi + \sigma - \rho$

We also note that since the VISSR FOV is along $\hat{I}_1'$

$$V_{I_3}' = 0 = V_{S_1}''' \sin(\zeta+\phi) + V_{S_3}''' \cos(\zeta+\phi)$$

or

$$\tan(\zeta+\phi) = -\frac{V_{S_3}'''}{V_{S_1}'''}$$

$$V_{S_3}''' = -V_{S_2}'' \sin\eta + V_{S_3}'' \cos\eta$$

$$= V_{S_3} \tan\eta \sin\eta + V_{S_3} \cos\eta \qquad \text{From eq (15a)}$$

$$= \frac{V_{S_3}}{\cos\eta}$$

$$V_{S_1}''' = V_{S_1}'' = V_{S_1} \cos(\theta+\rho) + V_{S_2} \sin(\theta+\rho)$$

$$= \sqrt{V_{S_1}^2 + V_{S_2}^2}\, \cos(\theta+\rho-\sigma)$$

$$V_{S_1}''' = \sqrt{V_{S_1}^2 + V_{S_2}^2}\, \cos\xi$$

Then

$$\tan(\zeta+\phi) = -\frac{V_{S_3}}{\cos\eta \cos\xi \sqrt{V_{S_1}^2 + V_{S_2}^2}} \qquad (19)$$

Finally the element E and the line L may be computed. In the equal angle mode of the S/DB the angular separation of elements μ_E

for the IR data (4x2 mile) is the ratio of the total data acquisition angle 2K ($K=9\ 3/16^{\circ}$) to the total number of samples S ($S=3822$):

$$\mu_E = \frac{2K}{S} \simeq 0.004807692^{\circ}$$

(The mode A visible data (½ x ½ mile) angular separation is $\frac{\mu_E}{4}$.) Since there are 3822 IR samples per line we shall let the center element CE number be 1911.5. Then

$$E = \frac{\theta}{\mu_E} + CE \tag{20}$$

Similarly the angular separation of scan lines is given by the VISSR mirror shaft encoder characteristic

$$\mu_L = \frac{45^{\circ}}{2^{12}} \simeq 0.01098633^{\circ}$$

When the scan mirror is at its reference line the scan count output by the VIP is L=911. In general we have:

$$L = 911 - \frac{\phi}{\mu_L} \tag{21}$$

6.0 TIME

The computation of satellite view vector requires knowledge of time which is not available until after computation of the desired VISSR elevation. The equations presented in the previous sections which result in the elevation angle can be denoted by $\phi_{i+1} = f(t_i)$. The time t_i is ideally the time at which the radiometer will scan the specified earth point. In practice it is estimated from ϕ_i using an equation $t_i = g(\phi_i)$, more specifically:

$$t_i = t_{i-1} - \frac{(\phi_i - \phi_{i-1})T}{\mu_L} \tag{22}$$

where T is the satellite spin period SPER; see Appendix A.

To start this iterative process we can estimate ϕ_1 using a spherical earth model, nominal synchronous orbit and nominal attitude. Then

$$\phi_1 = \tan^{-1}\left\{\frac{\sin\lambda'}{m-\cos\lambda'}\right\} - \zeta \tag{23}$$

where $m = 6.611$ is the distance from the satellite to earth center in units of earth radii.

If we let $t_o = t_F$ (the predicted frame start time) and let $\phi_o = 910\ \mu_L$ (the elevation angle at frame start) then:

$$t_1 = t_F - \left(\frac{\phi_1}{\mu_L} - 910\right) T \tag{24}$$

The iteration process will continue until either $|\phi_i - \phi_{i-1}|$ is less than some constant ε_ϕ or the iteration parameter i exceeds some constant I_ϕ. $\varepsilon_\phi = 2\text{x}10^{-6}$ radians.

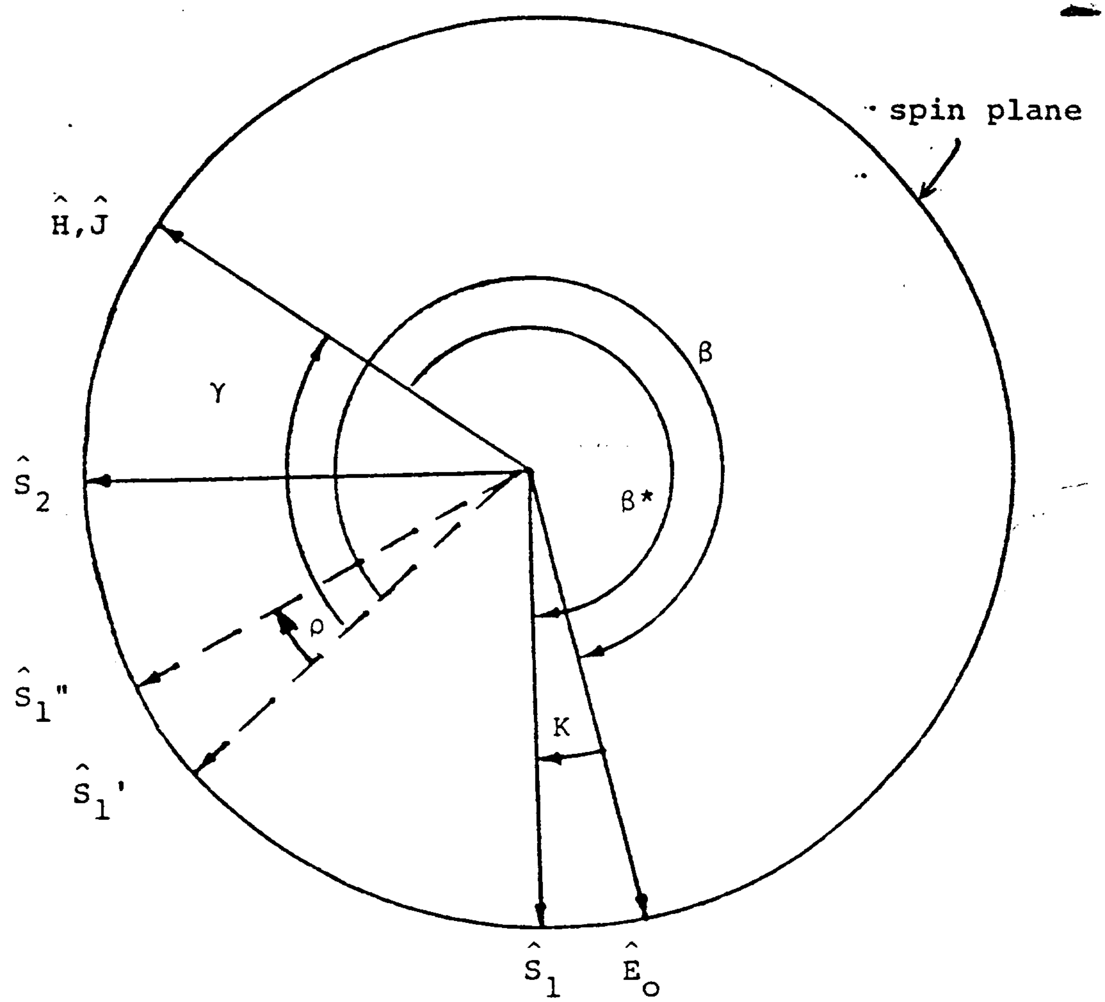
7.0 BETA ANGLE

Interpretation of the preceding equations requires an adequate understanding of the role played by the sun-earth angle beta. In this section this angle is defined and its relation to other angles is reviewed.

The line from the satellite to the sun can be projected into the spin plane and denoted by unit vector $\hat{H}$. Whenever the rotating sun sensor reference $\hat{J}$ becomes coincident with $\hat{H}$ a sun pulse is produced. Figure 7 is a view of the spin plane when $\hat{H}$ and $\hat{J}$ are aligned. The angle between $\hat{H}$ and $\hat{S}_1$ is denoted by β^*. We define a unit vector $\hat{E}_o$ at a fixed angle K from $\hat{S}_1$ ($K = 9\ 3/16^o$). Data acquisition by the S/DB commences whenever the rotating vector $\hat{S}_1'$ becomes aligned with $\hat{E}_o$; data acquisition then continues for a total angle of 2K degrees.

The angle β is defined as the satellite rotation angle from the $\hat{H}$-$\hat{J}$ coincidence until the following $\hat{E}_o$-$\hat{S}_1'$ coincidence. Then

$$\beta = \beta^* + \gamma - K \qquad (25)$$



$\hat{J}$: sun sensor

$\hat{H}$: sun-satellite projection

$\hat{S}_1$: earth-satellite projection

$\hat{E}_o$: data acquisition start line

$\hat{S}_1'$: predicted VISSR FOV plane-spin plane intersection

$\hat{S}_1''$: actual VISSR FOV plane-spin plane intersection

solid lines ——— Fixed coordinates

dashed lines - - - Rotating coordinates

Figure 7. Beta Geometry

ORBIT AND ATTITUDE BLOCK PARAMETER DOCUMENTATION

* All data are documented as integers generated by multiplication of a factor to preserve the required resolution. For example, the quantity ZETA in degrees was multiplied by 2**21 and the integer part of the product is shown in the O&A documentation. Thus the angle 10.0001 degrees is represented as 20973617.

NAME	UNIT	DESCRIPTION
DATE1	YYDDD in binary $_{10}$	Date for TIME1; DATE < 99366
TIME1	seconds * 100	Epoch (GMT); TIME1 < 864 x 10**4
TIME2	seconds * 100	Not documented; TIME1 + 468 x 10**4
XN YN ZN	km * 2**13	Satellite position at TIMEN in inertial coordinate system of date; N = 1 or 2
VXN VYN VZN	(km/hour) * 2**13	Satellite velocity at TIMEN
SPER	usec	Satellite spin period with respect to the earth at epoch
SPRAN	degrees * 2**21	Spin axis right ascension at TIMEN
SPDCN	degrees * 2**21	Spin axis declination at TIMEN
ZETA RHO ETA GAMMA	degrees * 2**21 " " "	VISSR alignment coordinates; ZETA = line bias, RHO = element bias, ETA = skew bias and GAMMA = sun pulse to VISSR angle.
NAME	coded	Most significant byte (8bits) contains source of O&A data: 1= NESDIS; 2 = UW, 3 = GSFC; next byte contains S/C name: 1 = GOES-4, 2 = GOES-5, 4 = GOES-F; least significant 16 bits contain the serial number of the O&A data.
ID	coded	Code to specify method used for O&A determination
SRAN	degrees * 2**21	Sun right ascension at TIMEN
SDCN	degrees * 2**21	Sun declination at TIMEN
GRAN	degrees * 2**21	Greenwich right ascension at TIMEN
EST	seconds * 100	Eclipse start time on DATE1
EET	seconds * 100	Eclipse end time on DATE1

NAME	UNIT	DESCRIPTION
FPER	microsecond	Satellite spin period with respect to sun at epoch plus 6.5 hours (neglecting eclipse effects).
TC	seconds	Eclipse thermal time constant
CEI	scan steps	Equitorial Scan Count Chebyshev parameters; 1=0, ...,3. Represents S/DB scan at which earth disk center is scanned.
CRI	msec * 100	Chebshev retransmisssion parameter; I=C, ...,3 represents time for signal to propagate from CDA station to satellite.
CBI	degrees * 273 * 2**11	Chebyshev Beta parameters; I=0, ..., 9
	(273 x 2*11 = 6289920/360 * 2**5)	
PNL	integer	Primary scanner north limit
RNL	integer	Redundant scanner north limit
CXI	km * 2**13	Chebyshev position parameters; I=0, ..., 10
CYI		
CZI		
EPY	YYMMDD (year, month, day)	Epoch time for keplerian elements
EPH	HHMMSS (hour, minute, second)	
SMA	km * 100	semi-major axis
ECC	unit less * 1000000	Eccentricity
INC	Degree * 1000	Inclimation see note below
MA	Degree * 1000	Mean Anomoly
AP	Degree * 1000	Argument of Perigee
RAN	Degree * 1000	Right Ascension of Ascending Node
SBSCAN	IR SCAN LINE * 100	subpoint scan number
SBSAMP	IR SAMPLE * 100	subpoint sample number
SBLAT	DEG * 100	subpoint latitude
SBLONG	DEG * 100	subpoint longitude
YAW	DEG * 1000	YAW angle
SBSCANB	IR scan line * 100	SBSCAN reformated in Binary coded decimal
SBSAMPB	IR SAMPLE * 100	SBSAMP reformated in BCD
SBLATB	DEG * 100	SBLAT reformated in BCD
SBLONGB	DEG * 100	SBLONG reformated in BCD
YAWB	DEG * 1000	YAW reformated in BCD

Note: The keplerian elements described above are generated by the NOAA "VISSR Image Registration and Gridding System" (VIRGS) and are documented here for use by similar systems.

ORBIT AND ATTITUDE DOCUMENTATION

Documentation Words	O&A Word Number										
99	Block Number*	$01	$02	$03	$04	$05	$06	$07	$08	$09	$0A
100	Minor Frame Index	**	**	**	**	**	**	**	**	**	**
101 - 104	1	DATE1	SPER	EST	CB0	CX0	CY0	CZ0	EPH	SBSCANB	-
105 - 108	2	TIME1	SPRA1	EET	CB1	CX1	CY1	CZ1	SMA	SBSAMB	SPRA2
109 - 112	3	-	SPDC1	FPER	CB2	CX2	CY2	CZ2	ECC	SBLATB	SPDC2
113 - 116	4	-	ZETA	TC	CB3	CX3	CY3	CZ3	INC	SBLONGB	DELTAL
117 - 120	5	-	RHO	CE0	CB4	CX4	CY4	CZ4	MA	YAWB	DELTAS
121 - 124	6	-	ETA	CE1	CB5	CX5	CY5	CZ5	AP	-	-
101 - 104	7	X1	GAMMA	CE2	CB6	CX6	CY6	CZ6	RAN	X2	-
105 - 108	8	Y1	NAMES	CE3	CB7	CX7	CY7	CZ7	SBSCAN	Y2	-
109 - 112	9	Z1	ID	CR0	CB8	CX8	CY8	CZ8	SBSAMP	Z2	-
113 - 116	10	VX1	SRA1	CR1	CB9	CX9	CY9	CZ9	SBLAT	VX2	SRA2
117 - 120	11	VY1	SDC1	CR2	PNL	CX10	CY10	CZ10	SBLONG	VY2	SDC2
121 - 124	12	VZ1	GRA1	CR3	RNL	-	-	EPY	YAW	VZ2	GRA2

* Block number = Minor frame index = $00 if O&A data not present; $ implies hexadecimal notation.

**Minor Frame Index = $01 if O&A Word Number is less than 7; MFI = $02 otherwise

APPENDIX D

GRIDDING MODE AAA DATA

TABLE OF CONTENTS

1.0 INTRODUCTION: Three Modes of Operation

In 1980, beginning with GOES 4, an enhanced instrument replaced the VISSR on the GOES spacecraft. The new instrument is intended to provide atmospheric sounding profile data in addition to visible and infrared imaging. The new instrument is called the VISSR Atmospheric Sounder, or VAS.

The VAS instrument differs from the VISSR in five significant ways:

1) In addition to the 7KM resolution IR sensors and the 1KM visible, there are two pairs of 14KM detectors. One pair is made of mercury and cadmium telluride and the other is indium antinomide. The two 7KM IR detectors are offset by one scan spacing unlike the VISSR.

2) The VAS contains a 12 channel filter wheel which can be positioned in front of all 6 IR detectors. The filter wheel's response bands range from 24.7 micron wavelength to 3.9 micron.

3) A temperature controlled blackbody is sensed once per spin to aid in calibration along with temperatures of other components within the optical system.

4) An on-board controller or processor, is provided to control the mirror position, detector selection and filter wheel position. The VAS processor is controlled by transmitting a table of values to it over the normal command link.

5) The Analog-to-Digital converter used for IR detectors in the VAS has a 10 bit resolution.

The VAS can be operated either as the instrument's presently operated, in the "VISSR MODE", or in one of two other VAS modes--MSI and Dwell Sounding. In the "VISSR MODE" the VAS on-board processor remains off resulting in only one pair of IR detectors being selected (generally the two small IR detectors). Also IR data is output as 8 bit values, and the VAS filter wheel is inactive. In the other two VAS modes, the VAS on-board processor is turned-on. The VAS requires a Processor Data Load (PDL), from ground station control (GMACS), to control its operation.

In the MSI mode the on-board processor switches detectors and filter wheel positions on alternate spins. By using an ingenious combination of large and small detectors, with different filter wheel positions, it is possible to obtain the full resolution visible and 7KM window (Band 8) IR images, plus two images from other IR channels each at 14KM resolution. It is also possible to obtain four different 14KM IR images by deleting the 7KM IR picture.

In the Dwell Sounding mode the mirror is not stepped on every satellite rotation. Instead, the filter wheel is stepped to all twelve positions allowing all twelve spectral bands to be sensed. In addition, some of the spectral bands are scanned several times in succession. By averaging these redundant samples, pixel for pixel, the signal-to-noise ratio of the detector can be improved. This averaging function is the principle reason for the increase from 8 to 10 bit resolution for the IR channels.

2.0 Detector Footprints, Spacing and Geometry

The spacecraft has eight visible, one pair of small IR (7KM) and two pair of large IR (14KM) detectors. For a given earth count (See Appendix B, Section IV for definition of earth count), the footprint overlay of the visible, small detector IR, and large detector IR sensors, is illustrated in Figure 1. The scanning mirror travels the distance of four visible pixels for each IR sample -- as a result, successive small IR pixels overlap each other by about 56 percent and successive large IR detectors overlap by 78 percent.

3.0 The MSI Mode

3.1 The Three-Stage MSI Process

In the Three-Stage MSI Mode, the spacecraft transmits one visible image, one small detector IR image (band 8 or an alternate), and two large detector IR images. The three IR bands are transmitted in an eight step sequence, with the small detector IR band being transmitted in the IR1 Block and two large detector bands transmitted on alternate spins in the IR2 Block as illustrated in Figures 2 and 4.

Each scan of data transmitted is uniquely stamped with an earth count M (see words 39,40 of the first Common Documentation Field contained in Blocks 2 and 3). This earth count applies only to the visible, grid and the IR1 video fields within that scan, and serves to reference them to the center of the earth (which will always have an earth count of 836).

In general the large detector IR information fields are transmitted out of sync with their corresponding visible and grid fields. To compensate, all IR fields are stamped separately with an "adjusted earth count" (contained in words 9 and 10 of the IR Documentation) that corresponds to the "Earth Count" of their corresponding visible and grid fields having the same earth coverage.

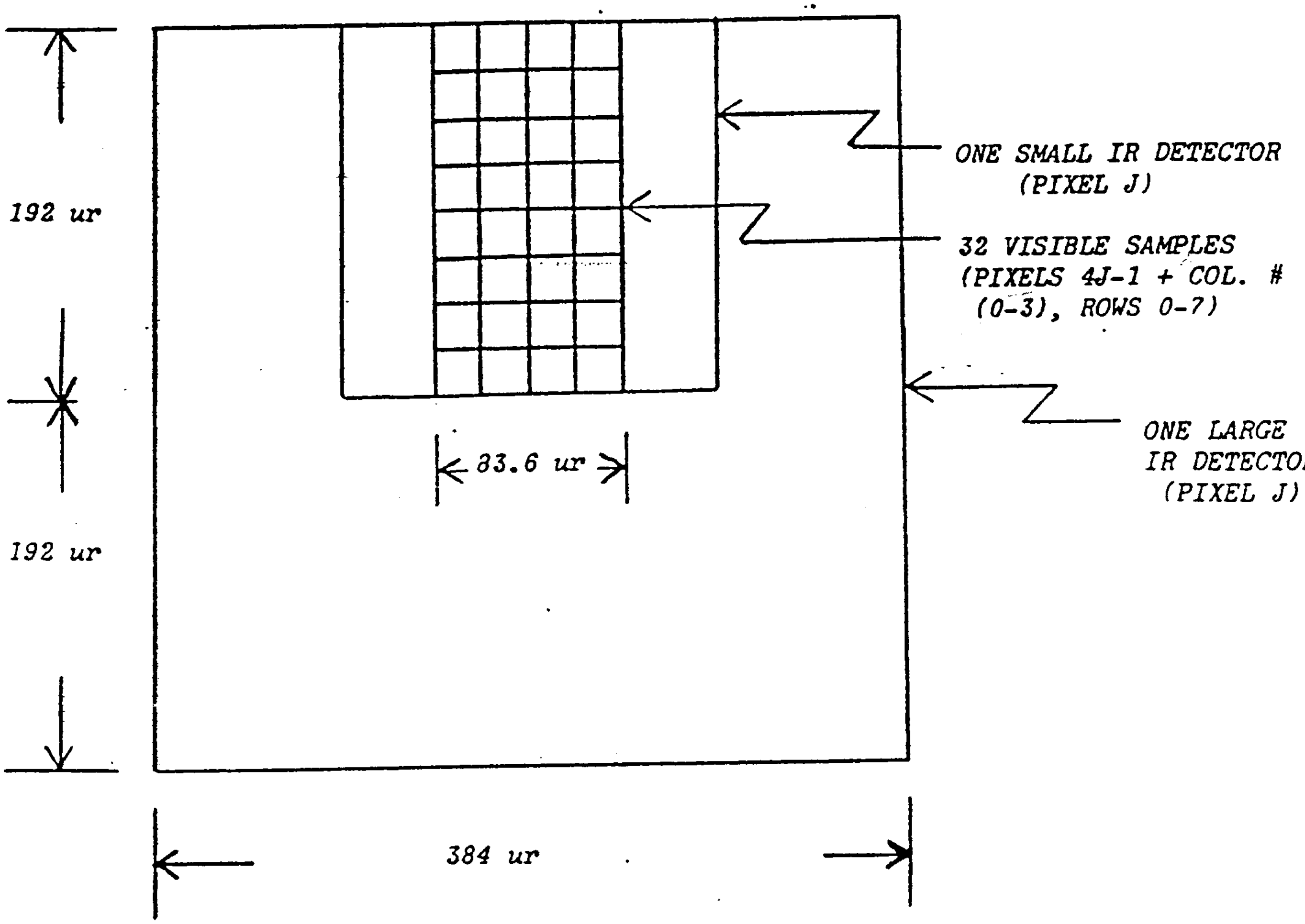


FIGURE 1 - RELATIONSHIP OF VAS DETECTORS HAVING THE SAME (ADJUSTED) EARTH COUNT

SCAN NUMBER	IR1 BAND	IR1 AREA COVERAGE	IR1 ADJUSTED EARTH COUNT	IR2 BAND	IR2 AREA COVERAGE	IR2 ADJUSTED EARTH COUNT	GRID & VISIBLE EARTH COUNT
N	A	M	M	C	M-1/M	M-1	M
N+1	A	M+1	M+1	B	M+1/M+2	M+1	M+1
N+2	A	M+2	M+2	C	M+1/M+2	M+1	M+2
N+3	A	M+3	M+3	B	M+3/M+4	M+3	M+3
N+4	A	M+4	M+4	C	M+3/M+4	M+3	M+4
N+5	A	M+5	M+5	B	M+5/M+6	M+5	M+5
N+6	A	M+6	M+6	C	M+5/M+6	M+5	M+6
N+7	A	M+7	M+7	B	M+7/M+8	M+7	M+7

EIGHT STEP SEQUENCE FOR THREE-STAGE MSI

SCAN NUMBER	IR1 BAND	IR1 AREA COVERAGE	IR1 ADJUSTED EARTH COUNT	IR2 BAND	IR2 AREA COVERAGE	IR2 ADJUSTED EARTH COUNT	GRID & VISIBLE EARTH COUNT
N	A	M/M+1	M	C	M/M+1	M	M
N+1	B	M+1/M+2	M+1	D	M+1/M+2	M+1	M+1
N+2	A	M+2/M+3	M+2	C	M+2/M+3	M+2	M+2
N+3	B	M+3/M+4	M+3	D	M+3/M+4	M+3	M+3
N+4	A	M+4/M+5	M+4	C	M+4/M+5	M+4	M+4
N+5	B	M+5/M+6	M+5	D	M+5/M+6	M+5	M+5
N+6	A	M+6/M+7	M+6	C	M+6/M+7	M+6	M+6
N+7	B	M+7/M+8	M+7	D	M+7/M+8	M+7	M+7

EIGHT STEP SEQUENCE FOR FOUR-STAGE MSI

FIGURE 2 - MODE AAA OUTPUT FOR 3 & 4 STAGE MSI SEQUENCES

3.2 The Four-Stage MSI Process

In the Four-Stage MSI Mode, the spacecraft transmits one visible image, and four large detector IR images. The four IR bands are transmitted in an eight step sequence as illustrated in Figures 2 and 5.

Unlike the three-stage case, there is a 1/2 pixel North-South offset between channels A & B, and between channels C & D. This is due to the way the VAS scanning mirror steps the distance of one small IR detector North-South from spin to spin, allowing the VAS instrument to "time-share" the two sets of large IR detectors. The effect of this process is to produce four seemingly simultaneous IR images. The time-sharing of large IR detectors is illustrated for bands A & B in Figure 3.

Again, as in the three-stage case, the four large detector IR bands are transmitted out of sync with their corresponding visible and grid fields. To compensate all IR fields are stamped with an "adjusted earth count" as before.

4.0 Gridding VAS Data

4.1 An Overview

Grid points are generated to the resolution of one visible pixel. Figure 1 shows the relative footprints of the visible, small IR, and large IR detectors. Understanding the relative footprints of these detectors, and how they are overlayed is the key to understanding how to grid VAS data.

As stated previously, each scan transmitted is stamped in the IR Common Documentation with an earth count to reference it to the scan through center of the earth disk. This earth count applies directly to the visible, grid and IR1 video fields. This allows a user to reference that grid set to corresponding large detector IR bands in IR2 that are transmitted on different spins.

Also, both the IR1 block and the IR2 block contain grid fields, but only the grid field contained in the IR1 block should be considered the master or primary grid set. The IR2 block may in the future be used to transmit alternate grid sets.

4.2 The Grid Field Encoding Scheme

Again, both the IR1 and IR2 blocks contain grid fields which each contain a list of up to 512 grid points. Each grid point consists of one twenty bit word-pair (two ten bit words concatenated) that maps that particular grid point into the IR and visible pixel spaces.

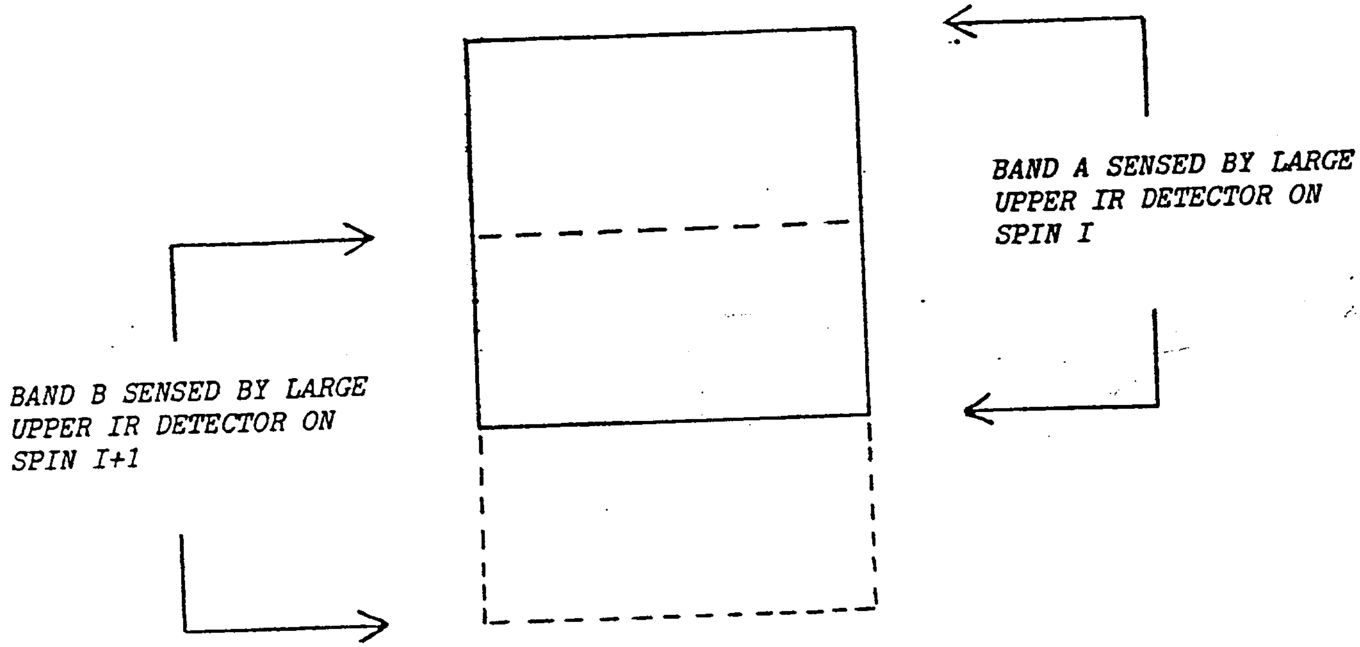
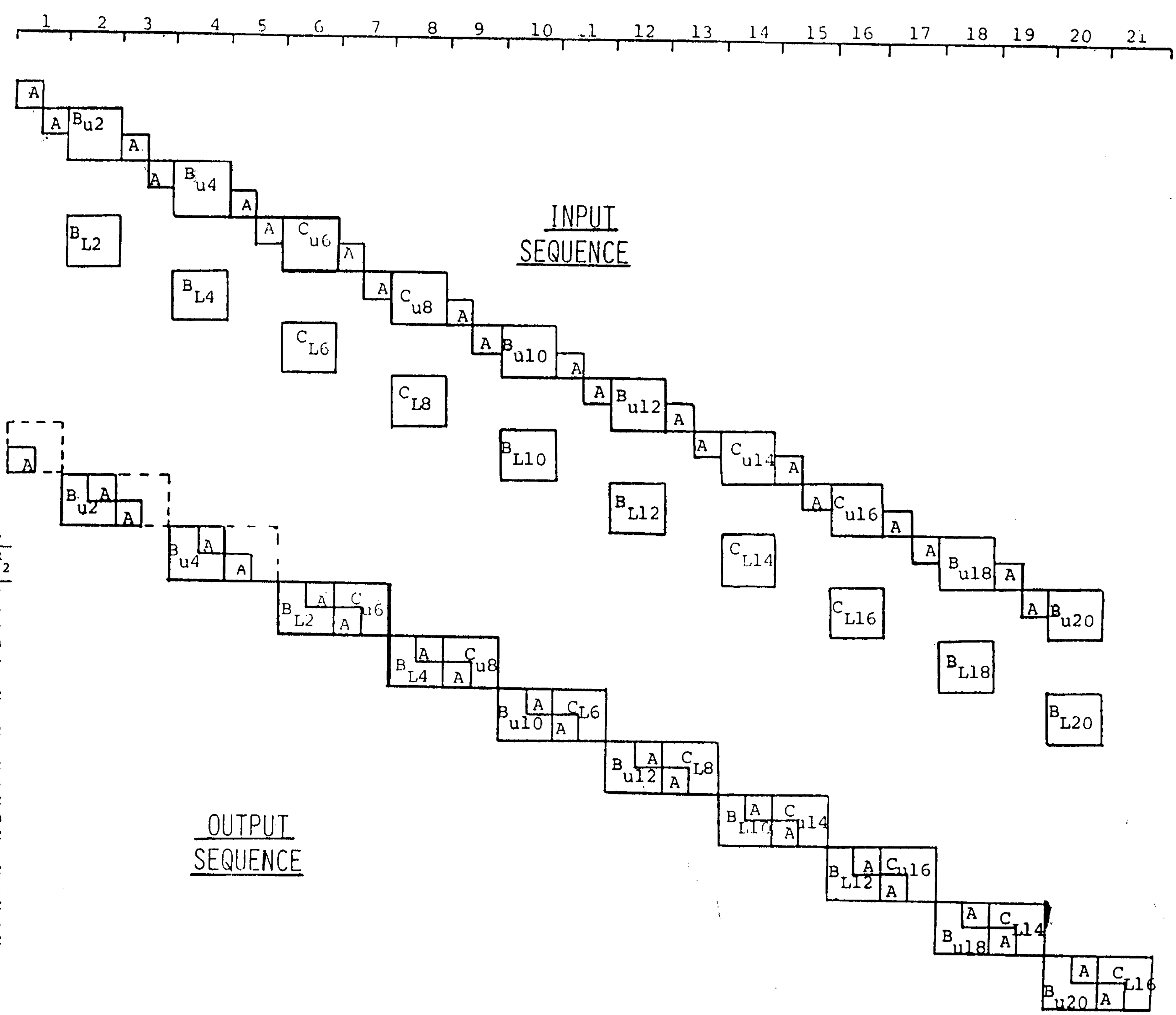


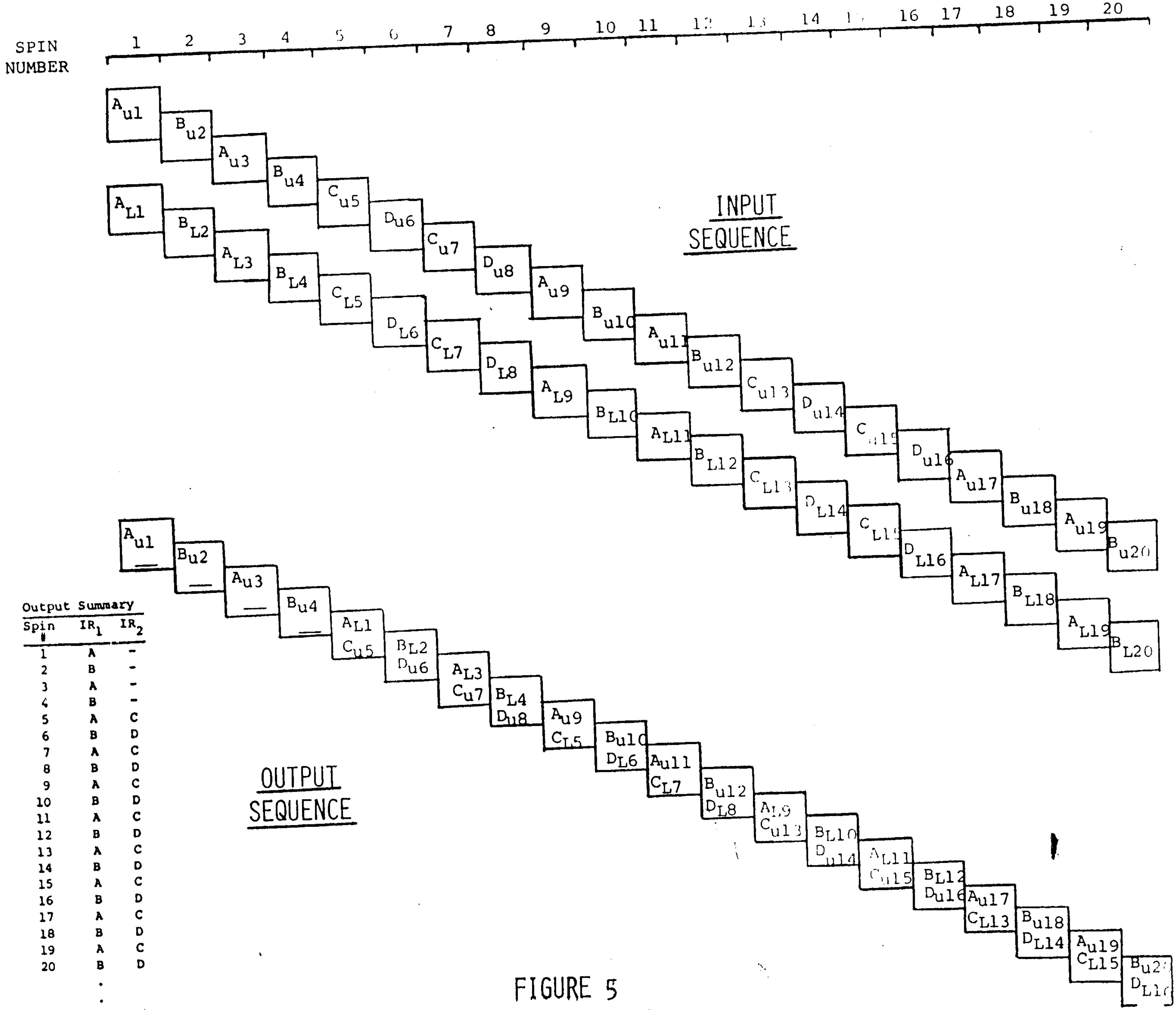
FIGURE 3- FOUR-STAGE MSI "TIME-SHARING" OF LARGE IR DETECTORS



Output Summary Spin #	IR_1	IR_2
1	A	-
2	A	B
3	A	-
4	A	B
5	A	-
6	A	B
7	A	C
8	A	B
9	A	C
10	A	B
11	A	C
12	A	B
13	A	C
14	A	B
15	A	C
16	A	B
17	A	C
18	A	B
19	A	C
20	A	B
21	A	C
.		
.		
.		

THREE STAGE MSI SEQUENCE

FIGURE 4



Output Summary

Spin #	IR_1	IR_2
1	A	-
2	B	-
3	A	-
4	B	-
5	A	C
6	B	D
7	A	C
8	B	D
9	A	C
10	B	D
11	A	C
12	B	D
13	A	C
14	B	D
15	A	C
16	B	D
17	A	C
18	B	D
19	A	C
20	B	D
.	.	
.	.	
.	.	

FIGURE 5
FOUR STAGE [illegible] SEQUENCE

A diagram of a grid point field is shown in Figure 6. Each of the grid point subfields are defined as follows:

IR Grid Pixel Location	- Designates the 7KM IR pixel to which that grid point corresponds. Also acts as the 12 most significant bits for the visible.
Tag Field	- Designates grid set membership. The general purpose grid set has a tag field of all zeros.
Visible Pixel Location	- Maps the grid pixel into a particular visible pixel contained within the 7KM IR visible pixel overlay matrix. This field consists of two subfields; Row Number and Column Number.

4.3 Gridding Visible Data

The earth count value transmitted in the Mode AAA IR Common Documentation (Blocks 2 & 3) of each scan applies to that scan's visible and grid fields.

The equation for determining which visible pixel a particular grid point corresponds to is: (See Section 4.2 for terms)

VIS PIXEL MAPPING = 4*("IR GRID PIXEL LOCATION"-1)+ "COLUMN NUMBER"

While "Row Number" (0-7 in binary, see Section 4.2) designates which of 8 visible information fields (1-8) that particular grid point corresponds to.

4.4 Gridding IR Data

4.4.1 Gridding 7KM (Small Detector) Data

Mapping grid points into 7KM IR data is an even simpler process than for visible data since the first 12 bits of the grid field point to the pixel to be gridded. The user should realize, of course, that more than one grid point may map into the same IR pixel. This should not be viewed as a problem however, and redundant grid points can simply be ignored.

<table>
<tr><th></th><th>1</th><th>2</th><th>3</th><th>4</th><th>5</th><th>6</th><th>7</th><th>8</th><th>9</th><th>10</th></tr>
<tr><td><u>Word</u></td><td colspan="10"></td></tr>
<tr><td>1</td><td colspan="10">IR GRID PIXEL LOCATION</td></tr>
<tr><td>2</td><td colspan="2">IR LSB</td><td colspan="3">TAG FIELD</td><td colspan="5">VIS PIXEL</td></tr>
<tr><td>3</td><td colspan="10">IR GRID PIXEL LOCATION</td></tr>
<tr><td>4</td><td colspan="2">IR LSB</td><td colspan="3">TAG FIELD</td><td colspan="5">VIS PIXEL</td></tr>
<tr><td>•</td><td colspan="10">•</td></tr>
<tr><td>•</td><td colspan="10">•</td></tr>
<tr><td>•</td><td colspan="10">•</td></tr>
<tr><td>1023</td><td colspan="10">IR GRID PIXEL LOCATION</td></tr>
<tr><td>1024</td><td colspan="2">IR LSB</td><td colspan="3">TAG FIELD</td><td colspan="5">VIS PIXEL</td></tr>
</table>

FIGURE 6 - SCHEMATIC OF MODE AAA GRID FIELD

In actual processing, the user would have to perform the following operations:

1) For each scan of small detector data received, grid IR1 data with the grid set contained within that same block (being sure to filter out any grid points with inappropriate Tag Fields).

2) Repeat the above process for subsequent scan lines.

4.4.2 Gridding Large Detector MSI Data

Mapping grid points into large detector IR data is a slightly more complex process than for small detector data. Although the large detectors are four times the size of the small IR detectors, the VAS instrument still outputs the same number of pixels (3822) per line. Therefore, gridding in the E-W direction will be the same, but two scans of grids must be applied to one large detector line of video.

An IR line with an "Adjusted Earth Count" of N would require the use of the Nth and the N+1th (earth count) grid sets. These grid sets could be merged to form a grid set of 1024 points, and then each pixel could be gridded as in the small detector case.

For the Four Stage MSI case, the grid sets corresponding to IR video received on scan N would be received on scan N and scan N+1 (the current scan, and the scan following). This is made clear in Figure 2 where the IR1 and IR2 adjusted earth counts correspond directly to the grid and visible earth counts received on the same scan. This is independent of what band is being processed.

This is also true of Band B in the Three Stage MSI case (again refer to Figure 2). But not for Band C. Band C in the Three Stage case is the only exception in that a video block of Band C received on scan N must be gridded with grid sets received on scans N-1 and N (the current scan and the previous scan). Figure 2 shows that the adjusted earth count for Band C corresponds to the earth count of the grid set received on the 'previous' scan. (Band A in the Three Stage case is the small detector band (contained in IR1) and so is not relevant to this discussion.)

As with the small detector case, the first 12 bits of the grid field points to the pixel to gridded. More than one grid point could map into the same IR pixel.

In actual processing the user would have to perform the following operations:

1) Buffer each video block as it arrives

2) Buffer the corresponding grid set received on that same scan, merge the buffered grid set with that received on the next scan, filter out any grid points with inappropriate tag fields, and merge the resulting grid set with the IR video.

3) Repeat for subsequent scan lines.

The following process would be followed when processing Band C data in the Three Stage MSI case:

1) Buffer each video block as it arrives.

2) Merge the buffered grid set (received on the previous scan) with that received on the current scan, filter out any grid points with inappropriate tag fields, and merge the resulting grid set with the IR video.

3) Repeat for subsequent scan lines.

To determine what mode the processor is in the user must follow the following procedure:

1) Inspect the mode word (word 24) contained in field two of the Common Documentation Block. Bit 9 = 1 indicates VAS mode operation.

2) Inspect bit 10 of the same word. Bit 10 = 1 indicates MSI mode operation.

3) Inspect the MSI band indicators (words 25-28) contained in the second field of the Common Documentation. If A=C=E=G and B=D=F=H then Two Stage MSI operation is indicated. If A=C=E=G and B=D and F=H then Three Stage MSI operation is indicated. Finally, if A=C, B=D, E=G, and F=H then Four Stage MSI operation is indicated.

If the processor is in Three Stage MSI mode, the user needs to know whether the band he is interested in coincides with Band B or Band C in the 8 step sequence. This may be determined by comparing the adjusted earth count (of the current spin) contained in the IR documentation block, to the earth count contained in the common documentation. As stated before, the adjusted earth count points to the grid set ("Tagged" by it's corresponding earth count) that coresponds to the current scan of IR video.

For Bands A, B, C, and D in the Four Stage, and Band B in the Three Stage, the adjusted earth count and the earth count will be equal (telling the user to merge the current and following (by one scan) grid fields to grid the IR video data). For Band C, in the Three Stage case, the adjusted earth count will be one less than the earth count encountered in the common documentation (thus pointing to the previous grid field, and telling the user to merge the previous and current grid fields to grid the current IR video).

5.0 Gridding VISSR Data

Occasionally, it will become necessary to operate one or more satellites in VISSR Mode. This will primarily be for special operations such as rapid imaging scanning operations (RISOP). In VISSR Mode the VAS processor is shut off and the VAS instrument behaves as if it were a VISSR.

In this mode only one IR image is transmitted during a single frame. This is usually a high resolution Band 8 IR image using only one (small) detector pair.

Mode AAA handles this special mode of operation by effectively transmitting the same IR image twice. During even numbered spins it transmits one IR image with data from the upper detector in IR1 and data from the lower detector in IR2. During odd numbered spins it transmits the same scene offset south by one scan line. In this case IR1 covers the same scene contained in IR2 on the previous spin.

For gridding purposes, this IR image can be treated identical to a MSI small detector image. Small detector IR data received in IR1 can be merged with its corresponding grid sets. IR data received in IR2 can be ignored.

An alternative to this is to use IR2 data exclusively (on a selectable basis), and gridding it with its corresponding grid sets (from IR2). This approach becomes more valuable in case of a detector failure, when imaging from one detector becomes a necessity. This is covered in more detail in Section 6.0.

6.0 Operation in the Presence of Failed Detectors

In the event an IR detector fails in the VAS instrument, it is likely that variations of the 3 and 4 stage MSI image sequences would be used.

6.1 Failed Small IR Detector

Should a small IR detector fail, the conventional three stage MSI sequence would no longer provide uniform coverage. In that mode every other IR1 block would have bad data since the small detector data is output alternating upper and lower detectors. In this event, two scenarios are likely: 1) the VISSR mode may be used almost exclusively since Band 8 is by far the highest priority IR channel; or 2) 4 stage MSI may be used more frequently with reduced spatial resolution. As discussed in Section 5, the VISSR mode normally provides redundant data (when both small detectors are working). In anticipation of a failure, the ability to choose data from either the upper detector (IR1) or the lower (IR2) is desirable for VISSR mode data.

6.2 Failed Large Detectors

In the event that one of two large detectors failed (either of the HgCdTe or the InSb type), a revised imaging sequence would be required if full coverage for spectral bands using the one remaining good detector were desired. A three stage MSI sequence would be replaced with what amounts to a two stage sequence as shown in Figure 7.

	IR1				IR2			
SCAN NUMBER	BAND	AREA	E.C.	DET.	BAND	AREA	E.C.	DET.
N	A	M	M	U	B	M-1/M	M-1	U
N+1	A	M+1	M+1	L	B	M+1/M+2	M+1	U
N+2	A	M+2	M+2	U	B	M+1/M+2	M+1	L
N+3	A	M+3	M+1	L	B	M+3/M+4	M+3	U
N+4	A	M+4	M+4	U	B	M+3/M+4	M+3	L
N+5	A	M+5	M+5	L	B	M+5/M+6	M+5	L
N+6	A	M+6	M+6	U	B	M+5/M+6	M+5	U
N+7	A	M+7	M+7	L	B	M+7/M+8	M+7	L

FIGURE 7. A Two Picture Sequence Using a Failed Large Detector

In this case, Band A is assumed to be a small detector (pair) and Band B is a large detector pair with one failed sensor. The satellite and ground system would continue to output data for both the upper and lower detector, and it is up to the user to select which of the two detectors is to be used. In this case the user must be sensitive to the Sector code in words 1 and 2 of the IR documentation and screen out the bad sensor data.

Other possible operating modes for a failed large detector are variations of a four stage MSI sequence in which the half-failed pair is sampled every other spin, similar to channels in the Two Stage case described above.

Again, the user would have to decide which detector (upper or lower) should be used to construct the image.

Appendix E AUXILIARY PRODUCT TRANSMISSIONS

The Processing/Distribution Unit (P/DU) ingests and formats all auxiliary product transmissions in Block 1 of the Mode AAA Format. Auxiliary data inputs come from one of four sources:

a. GMACS Text Message (always in ASCII)
b. P/DU Operator Generated Text Message (always in ASCII)
c. Averaged Dwell Sounding Product
d. Other Auxiliary Products (input via an aux products port that is interconnected to the VAS Data Utilization Center (VDUC) in Camp Springs, MD).

Although the scheduling of the auxiliary block is yet to be determined, the P/DU has an assigned priority for the auxiliary block. It is as follows:

a. Text Mesages first (GMACS then P/DU Operator)
b. Averaged Dwell Sounding Products which are internally generated by the P/DU and output only as auxiliary products (Block 1). During a dwell sounding raw sounding data is output in Blocks 2 and Block 3 as is done for imaging products.
c. Other Auxiliary Products awaiting transmission

Control of the auxiliary product transmissions is intented to be via the GMACS. The GMACS can disable all auxiliary product transmission, disable only dwell sounding products, or enable the P/DU to transmit all products contained in its queue.

Since the auxiliary block is new to the GOES Broadcast Format, its scheduling and usage are yet to be defined. At present the P/DU will output any text message immediately after receipt from either the GMACS or by operator command. If the dwell sounding flag is enabled, the P/DU will generate and output an averaged dwell sounding radiance product. If other auxiliary products are properly formatted and input to the P/DU it will output the products in a first in/ first out fashion. It should be noted that the GMACS can, to a limited extent, rearrange the output order of any dwell sounding or other auxiliary product transmission.

The Operational VAS Mode AAA Specification defines the header format for the Auxiliary Block. Table E-1 describes the contents of selected header words for the Auxiliary Block, especially in relation to aux. product types. Table E-2 defines the contents of the Average Dwell Sounding Product records. Table E-3 defines the contents of the External Product records.

E.1 Average Dwell Sounding Products

Average Dwell Sounding (DS) products are generated by the Processing/ Distribution Unit (P/DU). The P/DU executes this task during a VAS DS, if enabled by the GMACS or the P/DU operator. During a VAS DS the P/DU outputs raw DS IR video data in blocks 2 and 3 and the average DS product in block 1 of Mode AAA. Raw DS IR is output whether average DS product transmissions are enabled or not. Raw DS IR video data is not rearranged geographically (e.g. deinterleaved) or grided as MSI IR data is. The average DS product consists of a running average of DS lines which are rearranged in their NS orientation (deinterleaved) if large IR data is involved, grided, and output as either a sounding sequence data set or a total averaged DS product. A sounding sequence consists of two S_2 dwell periods (e.g. positions when the mirror is not stepping) and individual S_1 and S_3 submodes. Thus a sounding sequence is represented as follows: S_1, S_2, S_3, S_2 where S_1 is nominally six (6) mirror steps, S_3 is nominally two (2) mirror steps, and the number of S_2 spins are given by the PDL. A VAS DS may contain N sounding sequences. A total DS product may contain averaged DS data from only one VAS PDL or may be concatenated, via command, to represent the P/DU's total averaged DS buffer (up to an hour worth of products). The order of the spectral band output in an averaged DS product is identical to that in any dwell sounding. This is primarily because the VAS is preprogrammed in the following sequence:

DS Spectral Band Sequence - 11, 6, 10, 12, 7, 8, 5, 4, 9, 3, 2, & 1

Hence, Spectral Band eleven sounding data is followed by Spectral Band 6 sounding data, by Spectral Band ten data, and so forth.

As noted on the previous page, P/DU auxiliary product transmissions have a priority three status that is--higher than other auxiliary products but lower than any text messages.

Table E-1: AUXILIARY BLOCK 1 HEADER FORMAT

WORD NUMBER	DESCRIPTION
5-6	Product ID (Binary) 11 - GMACS Text Message 12 - P/DU Operator Text Message 13 - Average Dwell Sounding Product 1001 - 65535 - Other Auxiliary Product assigned by VDUC in bytes 7-8 of the application header.
8	Version Number: Sounding Products: Product ID, 1-100, P/DU Assigned Other Auxiliary Products: Version Number Assigned by VDUC (Byte 9 of application header)
15	Sounding Product Record Type: 0 - Averaged IR Sounding Record 1 - Grid Record 2 - Common Documentation

Table E-2: SOUNDING PRODUCT RECORD FORMATS

GRID RECORD FORMAT

WORD NUMBER	DESCRIPTION
1	BCD Scan Count (Most significant 2 digits)
2	BCD Scan Count (Least significant 2 digits)
3	BCD Earth Count (Most significant 2 digits)
4	BCD Earth Count (Least Significant 2 digits)
5 - 1028	Grid 1 data (Primary grid), in AAA format, for the scan/earth count in words 1-4.
1029 - 2052	Grid 1 data (Primary grid), in AAA format, for the next scan/earth count.
2053 - 3076	Grid 2 data (Backup grid), in AAA format, for the scan/earth count in words 1-4.
3077 - 4100	Grid 2 data (Backup grid), in AAA format, for the next scan/earth count.

NOTE:

All data words are 16 bits long. The information in each data word is either 8 bits long (BCD counts) or 10 bits long (AAA-grid data), but it is always right-justified.

TABLE E-2: SOUNDING PRODUCT RECORD FORMATS (con't)

SOUNDING RECORD FORMAT

WORD NUMBER	DESCRIPTION
1 - 16	IR Documentation data associated with the first IR block received by the P/DU for this scan and spectral band.
17 - 3838	Averaged IR sounding data for this scan and spectral band.

NOTE:

All data words are 16 bits long. The information in each data word is either 8 or 10 bits long, and right-justified.

TABLE E-2: SOUNDING PRODUCTS RECORD FORMAT (con't)

COMMON DOCUMENTATION WORDS

	WORD NUMBER	DESCRIPTION
First Record	1 - 512	Common Documentation block #1
	513-1024	Common Documentation block #2
	*	*
	*	*
	*	*
	3585-4096	Common Documentation block #8
Second Record	1 - 512	Common Documentation block #9
	513-1024	Common Documentation block #10
	*	*
	*	*
	*	*
	3585-4096	Common Documentation block #16
Third Record	1 - 512	Common Documentation block #17
	*	*
	*	*
	*	*
	1537-2048	Common Documentation block #20

NOTES:

1. All data words are 16 bits long. The information in each word is either 8 or 10 bits long, and right-justified.

2. Documentation blocks are numbered sequentially 1 through 20, based on the Block Number (Word 99, First Field of Common Documentation) and the Minor Frame Index (Word 100, First Field): I = Block Number *2 + Minor Frame Index

Table E-3: OTHER EXTERNAL PRODUCT P/DU INGEST FORMAT

BYTE NUMBER	DESCRIPTION
1 - 2	Total Number of data words in the Product Record (Other product only)
3	Word Size of the Information Field (in bits 6, 8, or 10)
4	Data Type (1 - ASCII, 0 - Binary)
5 - 6	Data Source (external source ID)
7 - 8	Product ID assigned by External Source This is put in AAA-Header Words 5-6. It is in the range 1001-65535.
9	Version Number of the Product (also AAA-Header Word 8)
10	Start/End Product Flag 1 - Start of Product (first record) 2 - End of Product (last record) 3 - Both (only one record) 0 - Neither (in between record)
11 - 12	P/DU Product ID (internally assigned 1-100)
13 -	Data Information Field: all data (six, eight, or ten bit words) are packed into the P/DU's disk storage in 8-bit bytes. The total length of the information field is given by: $\text{Length} = \frac{(\text{Number of Words} * \text{Word Size} + 7)}{8}$

NOTE: The information contained in this table is provided for the Mode AAA Users interest only. The Table shows how an auxiliary data product record is ingest into the P/DU.

APPENDIX F Mode AAA to Mode A Conversion Table

1. The VIP conversion of the ten bit pixel value, P, to radiance, R, in the infrared window channel is given by the formula:

$$R = A*P - B \quad mW/m^2 \text{ str } cm^{-1}$$

where

A = 0.24

B = 10.00

The offset B accounts for radiation from the telescope for optics and other effects. The slope A yeilds the average radiance (110 for the 891.4 cm^{-1} Band 8) at a pixel value of 500 (thus using nine of the available ten bits). A and B were based on GOES-5 data over the interval summer 1982 to summer 1983. These parameters should be updated to reflect GOES-6 performance (most likely they won't change at all).

2. The conversion from radiance, R, to temperature, T, is accomplished with the following:

$$T = \left[\frac{FK2}{ALOG(FK1/R + 1)} - TC1\right]/TC2$$

where the constants for the infrared window are:

FK1 = 8438.

FK2 = 1283.

TC1 = 0.3263

TC2 = 0.9973

This conversion accounts for the spectral response characteristics of the infrared window bandpass filter on GOES-6.

3. Using the two algorithums, a Mode AAA to Mode A Conversion Table can be produced. At the pixel value 500, the brightness temperature value differs by three counts. A Table and the software that created it are contained as the remainder of Appendix F.

```
//PAUL5510 JOB  CLASS=B,MSGLEVEL=(0,0)
//* VDPAUL   ALS  09/28/84: MEMBER UPDATED
// EXEC  MCPRG,MOD=PAUL
//FORT.SYSIN  DD  *
      SUBROUTINE MAINO
C MODE AAA TO MODE A TABLE CONVERSION
      DIMENSION MOUT(120)
      DATA A/0.24/,B/10.0/,XNU/909.09/
      DATA C1/1.1910659E-5/,C2/1.438833/
      DATA FK1/8438./,FK2/1283./,TC1/.3263/,TC2/.9973/
      DO 30 I=1,1024
      II=I-1
      R=A*II-B
      IF(R.GT.0) GOTO 10
      R=0.0
      T=0.0
      GOTO 20
10    SAVE=1.0+FK1/R
      T=FK2/ALOG(SAVE)
      T=(T-TC1)/TC2
20    IF(T.LT.164.0) IC=254
      IF((T.GT.164.0).AND.(T.LT.242.0)) IC=418.5-T
      IF((T.GE.242.0).AND.(T.LE.330.0)) IC=660.5-2.0*T
      IF(T.GT.330.0) IC=0
      CALL ENKODE('(120X)',MOUT)
      CALL ENKODE('(2X,I5,4X,I8,4X,F10.3,4X,F10.4/)',
     MOUT,II,IC,R,T)
30    CONTINUE
      RETURN
      END
/*
//
```

Mode AAA To Mode A Computer Listing

MODE AAA TO MODE A LOOKUP TABLE

Mode AAA Count	Mode A Count		Brightness Temperature
0	254	0.000	0.0000
1	254	0.000	0.0000
2	254	0.000	0.0000
3	254	0.000	0.0000
4	254	0.000	0.0000
5	254	0.000	0.0000
6	254	0.000	0.0000
7	254	0.000	0.0000
8	254	0.000	0.0000
9	254	0.000	0.0000
10	254	0.000	0.0000
11	254	0.000	0.0000
12	254	0.000	0.0000
13	254	0.000	0.0000
14	254	0.000	0.0000
15	254	0.000	0.0000
16	254	0.000	0.0000
17	254	0.000	0.0000
18	254	0.000	0.0000
19	254	0.000	0.0000
20	254	0.000	0.0000
21	254	0.000	0.0000
22	254	0.000	0.0000
23	254	0.000	0.0000
24	254	0.000	0.0000
25	254	0.000	0.0000
26	254	0.000	0.0000
27	254	0.000	0.0000
28	254	0.000	0.0000
29	254	0.000	0.0000
30	254	0.000	0.0000
31	254	0.000	0.0000
32	254	0.000	0.0000
33	254	0.000	0.0000
34	254	0.000	0.0000
35	254	0.000	0.0000
36	254	0.000	0.0000
37	254	0.000	0.0000
38	254	0.000	0.0000
39	254	0.000	0.0000
40	254	0.000	0.0000
41	254	0.000	0.0000
42	254	0.080	110.8993
43	254	0.320	126.0457
44	254	0.560	133.3964
45	254	0.800	138.5447
46	254	1.040	142.5919
47	254	1.280	145.9661
48	254	1.520	148.8815
49	254	1.760	151.4619
50	254	2.000	153.7859
51	254	2.240	155.9064
52	254	2.480	157.8612
53	254	2.720	159.6781
54	254	2.960	161.3781
55	254	3.200	162.9779
56	254	3.440	164.4903
57	252	3.680	165.9262
58	251	3.920	167.2942
59	249	4.160	168.6015
60	248	4.400	169.8543
61	247	4.640	171.0577
62	246	4.880	172.2163
63	245	5.120	173.3339

64	244	5.360	174.4138
65	243	5.600	175.4590
66	242	5.840	176.4721
67	241	6.080	177.4553
68	240	6.320	178.4109
69	239	6.560	179.3406
70	238	6.800	180.2460
71	237	7.040	181.1287
72	236	7.280	181.9901
73	235	7.520	182.8312
74	234	7.760	183.6534
75	234	8.000	184.4576
76	233	8.240	185.2447
77	232	8.480	186.0157
78	231	8.720	186.7712
79	230	8.960	187.5122
80	230	9.200	188.2392
81	229	9.440	188.9529
82	228	9.680	189.6539
83	228	9.920	190.3427
84	227	10.160	191.0198
85	226	10.400	191.6858
86	226	10.640	192.3411
87	225	10.880	192.9860
88	224	11.120	193.6211
89	224	11.360	194.2466
90	223	11.600	194.8630
91	223	11.840	195.4705
92	222	12.080	196.0695
93	221	12.320	196.6603
94	221	12.560	197.2431
95	220	12.800	197.8182
96	220	13.040	198.3859
97	219	13.280	198.9463
98	219	13.520	199.4999
99	218	13.760	200.0466
100	217	14.000	200.5869
101	217	14.240	201.1207
102	216	14.480	201.6484
103	216	14.720	202.1701
104	215	14.960	202.6860
105	215	15.200	203.1963
106	214	15.440	203.7010
107	214	15.680	204.2005
108	213	15.920	204.6946
109	213	16.160	205.1838
110	212	16.400	205.6680
111	212	16.640	206.1473
112	211	16.880	206.6221
113	211	17.120	207.0922
114	210	17.360	207.5578
115	210	17.600	208.0191
116	210	17.840	208.4762
117	209	18.080	208.9291
118	209	18.320	209.3779
119	208	18.560	209.8228
120	208	18.800	210.2638
121	207	19.040	210.7011
122	207	19.280	211.1346
123	206	19.520	211.5645
124	206	19.760	211.9908
125	206	20.000	212.4137
126	205	20.240	212.8332
127	205	20.480	213.2493
128	204	20.720	213.6622
129	204	20.960	214.0719

130	204	21.200	214.4785
131	203	21.440	214.8820
132	203	21.680	215.2825
133	202	21.920	215.6800
134	202	22.160	216.0746
135	202	22.400	216.4664
136	201	22.640	216.8554
137	201	22.880	217.2417
138	200	23.120	217.6253
139	200	23.360	218.0063
140	200	23.600	218.3846
141	199	23.840	218.7604
142	199	24.080	219.1337
143	198	24.320	219.5046
144	198	24.560	219.8730
145	198	24.800	220.2391
146	197	25.040	220.6028
147	197	25.280	220.9643
148	197	25.520	221.3234
149	196	25.760	221.6804
150	196	26.000	222.0352
151	196	26.240	222.3878
152	195	26.480	222.7383
153	195	26.720	223.0867
154	195	26.960	223.4331
155	194	27.200	223.7775
156	194	27.440	224.1198
157	194	27.680	224.4602
158	193	27.920	224.7987
159	193	28.160	225.1353
160	193	28.400	225.4700
161	192	28.640	225.8029
162	192	28.880	226.1339
163	192	29.120	226.4632
164	191	29.360	226.7907
165	191	29.600	227.1165
166	191	29.840	227.4405
167	190	30.080	227.7628
168	190	30.320	228.0835
169	190	30.560	228.4026
170	189	30.800	228.7200
171	189	31.040	229.0358
172	189	31.280	229.3501
173	188	31.520	229.6627
174	188	31.760	229.9739
175	188	32.000	230.2834
176	187	32.240	230.5916
177	187	32.480	230.8983
178	187	32.720	231.2034
179	186	32.960	231.5072
180	186	33.200	231.8095
181	186	33.440	232.1104
182	186	33.680	232.4099
183	185	33.920	232.7081
184	185	34.160	233.0049
185	185	34.400	233.3004
186	184	34.640	233.5945
187	184	34.880	233.8874
188	184	35.120	234.1789
189	184	35.360	234.4692
190	183	35.600	234.7582
191	183	35.840	235.0460
192	183	36.080	235.3325
193	182	36.320	235.6179
194	182	36.560	235.9019
195	182	36.800	236.1849

196	182	37.040	236.4667
197	181	37.280	236.7473
198	181	37.520	237.0267
199	181	37.760	237.3050
200	180	38.000	237.5822
201	180	38.240	237.8583
202	180	38.480	238.1333
203	180	38.720	238.4072
204	179	38.960	238.6799
205	179	39.200	238.9517
206	179	39.440	239.2224
207	179	39.680	239.4921
208	178	39.920	239.7607
209	178	40.160	240.0282
210	178	40.400	240.2949
211	177	40.640	240.5605
212	177	40.880	240.8250
213	177	41.120	241.0887
214	177	41.360	241.3513
215	176	41.600	241.6130
216	176	41.840	241.8738
217	176	42.080	242.1336
218	175	42.320	242.3924
219	175	42.560	242.6504
220	174	42.800	242.9074
221	174	43.040	243.1635
222	173	43.280	243.4187
223	173	43.520	243.6731
224	172	43.760	243.9265
225	172	44.000	244.1792
226	171	44.240	244.4309
227	171	44.480	244.6818
228	170	44.720	244.9318
229	170	44.960	245.1810
230	169	45.200	245.4293
231	169	45.440	245.6769
232	168	45.680	245.9236
233	168	45.920	246.1695
234	167	46.160	246.4147
235	167	46.400	246.6590
236	166	46.640	246.9025
237	166	46.880	247.1452
238	165	47.120	247.3872
239	165	47.360	247.6285
240	164	47.600	247.8689
241	164	47.840	248.1086
242	163	48.080	248.3476
243	163	48.320	248.5858
244	162	48.560	248.8233
245	162	48.800	249.0600
246	161	49.040	249.2960
247	161	49.280	249.5314
248	160	49.520	249.7660
249	160	49.760	249.9999
250	160	50.000	250.2331
251	159	50.240	250.4656
252	159	50.480	250.6974
253	158	50.720	250.9286
254	158	50.960	251.1590
255	157	51.200	251.3889
256	157	51.440	251.6180
257	156	51.680	251.8465
258	156	51.920	252.0744
259	155	52.160	252.3015
260	155	52.400	252.5281
261	154	52.640	252.7540

262	154	52.880	252.9792
263	154	53.120	253.2039
264	153	53.360	253.4279
265	153	53.600	253.6513
266	152	53.840	253.8741
267	152	54.080	254.0963
268	151	54.320	254.3179
269	151	54.560	254.5388
270	150	54.800	254.7592
271	150	55.040	254.9790
272	150	55.280	255.1982
273	149	55.520	255.4168
274	149	55.760	255.6349
275	148	56.000	255.8523
276	148	56.240	256.0690
277	147	56.480	256.2854
278	147	56.720	256.5012
279	147	56.960	256.7165
280	146	57.200	256.9309
281	146	57.440	257.1450
282	145	57.680	257.3586
283	145	57.920	257.5717
284	144	58.160	257.7841
285	144	58.400	257.9963
286	144	58.640	258.2075
287	143	58.880	258.4184
288	143	59.120	258.6289
289	142	59.360	258.8388
290	142	59.600	259.0480
291	141	59.840	259.2570
292	141	60.080	259.4653
293	141	60.320	259.6730
294	140	60.560	259.8806
295	140	60.800	260.0874
296	139	61.040	260.2937
297	139	61.280	260.4995
298	139	61.520	260.7050
299	138	61.760	260.9099
300	138	62.000	261.1142
301	137	62.240	261.3181
302	137	62.480	261.5217
303	137	62.720	261.7246
304	136	62.960	261.9272
305	136	63.200	262.1291
306	135	63.440	262.3310
307	135	63.680	262.5319
308	135	63.920	262.7326
309	134	64.160	262.9328
310	134	64.400	263.1328
311	133	64.640	263.3320
312	133	64.880	263.5307
313	133	65.120	263.7292
314	132	65.360	263.9272
315	132	65.600	264.1247
316	131	65.840	264.3220
317	131	66.080	264.5187
318	131	66.320	264.7150
319	130	66.560	264.9108
320	130	66.800	265.1062
321	129	67.040	265.3012
322	129	67.280	265.4958
323	129	67.520	265.6899
324	128	67.760	265.8837
325	128	68.000	266.0771
326	127	68.240	266.2700
327	127	68.480	266.4626

328	127	68.720	266.6547
329	126	68.960	266.8466
330	126	69.200	267.0378
331	126	69.440	267.2287
332	125	69.680	267.4194
333	125	69.920	267.6096
334	124	70.160	267.7993
335	124	70.400	267.9887
336	124	70.640	268.1777
337	123	70.880	268.3662
338	123	71.120	268.5544
339	123	71.360	268.7426
340	122	71.600	268.9301
341	122	71.840	269.1171
342	121	72.080	269.3039
343	121	72.320	269.4902
344	121	72.560	269.6762
345	120	72.800	269.8618
346	120	73.040	270.0471
347	120	73.280	270.2321
348	119	73.520	270.4167
349	119	73.760	270.6008
350	118	74.000	270.7849
351	118	74.240	270.9682
352	118	74.480	271.1513
353	117	74.720	271.3342
354	117	74.960	271.5166
355	117	75.200	271.6987
356	116	75.440	271.8806
357	116	75.680	272.0620
358	116	75.920	272.2431
359	115	76.160	272.4238
360	115	76.400	272.6042
361	114	76.640	272.7844
362	114	76.880	272.9641
363	114	77.120	273.1437
364	113	77.360	273.3227
365	113	77.600	273.5014
366	113	77.840	273.6801
367	112	78.080	273.8581
368	112	78.320	274.0361
369	112	78.560	274.2136
370	111	78.800	274.3906
371	111	79.040	274.5676
372	111	79.280	274.7441
373	110	79.520	274.9204
374	110	79.760	275.0964
375	109	80.000	275.2719
376	109	80.240	275.4472
377	109	80.480	275.6223
378	108	80.720	275.7971
379	108	80.960	275.9711
380	108	81.200	276.1452
381	107	81.440	276.3190
382	107	81.680	276.4926
383	107	81.920	276.6657
384	106	82.160	276.8388
385	106	82.400	277.0114
386	106	82.640	277.1835
387	105	82.880	277.3557
388	105	83.120	277.5275
389	105	83.360	277.6989
390	104	83.600	277.8698
391	104	83.840	278.0407
392	104	84.080	278.2114
393	103	84.320	278.3818

394	103	84.560	278.5517
395	103	84.800	278.7216
396	102	85.040	278.8911
397	102	85.280	279.0603
398	102	85.520	279.2292
399	101	85.760	279.3977
400	101	86.000	279.5661
401	101	86.240	279.7341
402	100	86.480	279.9020
403	100	86.720	280.0695
404	100	86.960	280.2370
405	99	87.200	280.4040
406	99	87.440	280.5705
407	99	87.680	280.7370
408	98	87.920	280.9033
409	98	88.160	281.0693
410	98	88.400	281.2351
411	97	88.640	281.4006
412	97	88.880	281.5656
413	97	89.120	281.7304
414	96	89.360	281.8952
415	96	89.600	282.0595
416	96	89.840	282.2238
417	95	90.080	282.3874
418	95	90.320	282.5512
419	95	90.560	282.7148
420	94	90.800	282.8779
421	94	91.040	283.0410
422	94	91.280	283.2033
423	93	91.520	283.3657
424	93	91.760	283.5280
425	93	92.000	283.6899
426	92	92.240	283.8518
427	92	92.480	284.0129
428	92	92.720	284.1743
429	91	92.960	284.3352
430	91	93.200	284.4960
431	91	93.440	284.6567
432	90	93.680	284.8166
433	90	93.920	284.9768
434	90	94.160	285.1367
435	89	94.400	285.2963
436	89	94.640	285.4553
437	89	94.880	285.6145
438	88	95.120	285.7734
439	88	95.360	285.9321
440	88	95.600	286.0903
441	88	95.840	286.2485
442	87	96.080	286.4067
443	87	96.320	286.5644
444	87	96.560	286.7216
445	86	96.800	286.8791
446	86	97.040	287.0361
447	86	97.280	287.1931
448	85	97.520	287.3496
449	85	97.760	287.5061
450	85	98.000	287.6623
451	84	98.240	287.8183
452	84	98.480	287.9738
453	84	98.720	288.1293
454	83	98.960	288.2849
455	83	99.200	288.4396
456	83	99.440	288.5947
457	83	99.680	288.7495
458	82	99.920	288.9040
459	82	100.160	289.0581

460	82	100.400	289.2121
461	81	100.840	289.3662
462	81	100.880	289.5195
463	81	101.120	289.6730
464	80	101.360	289.8264
465	80	101.600	289.9792
466	80	101.840	290.1320
467	79	102.080	290.2849
468	79	102.320	290.4370
469	79	102.560	290.5893
470	79	102.800	290.7414
471	78	103.040	290.8933
472	78	103.280	291.0446
473	78	103.520	291.1960
474	77	103.760	291.3474
475	77	104.000	291.4982
476	77	104.240	291.6491
477	76	104.480	291.7998
478	76	104.720	291.9501
479	76	104.960	292.1003
480	75	105.200	292.2504
481	75	105.440	292.4001
482	75	105.680	292.5500
483	75	105.920	292.6992
484	74	106.160	292.8486
485	74	106.400	292.9978
486	74	106.640	293.1464
487	73	106.880	293.2951
488	73	107.120	293.4438
489	73	107.360	293.5920
490	73	107.600	293.7402
491	72	107.840	293.8884
492	72	108.080	294.0358
493	72	108.320	294.1835
494	71	108.560	294.3310
495	71	108.800	294.4780
496	71	109.040	294.6252
497	70	109.280	294.7719
498	70	109.520	294.9187
499	70	109.760	295.0654
500	70	110.000	295.2114
501	69	110.240	295.3576
502	69	110.480	295.5039
503	69	110.720	295.6494
504	68	110.960	295.7951
505	68	111.200	295.9404
506	68	111.440	296.0856
507	68	111.680	296.2309
508	67	111.920	296.3757
509	67	112.160	296.5205
510	67	112.400	296.6650
511	66	112.640	296.8093
512	66	112.880	296.9536
513	66	113.120	297.0976
514	66	113.360	297.2416
515	65	113.600	297.3852
516	65	113.840	297.5288
517	65	114.080	297.6718
518	64	114.320	297.8154
519	64	114.560	297.9584
520	64	114.800	298.1010
521	64	115.040	298.2438
522	63	115.280	298.3862
523	63	115.520	298.5288
524	63	115.760	298.6711
525	62	116.000	298.8129

526	62	116.240	298.9550
527	62	116.480	299.0966
528	62	116.720	299.2382
529	61	116.960	299.3796
530	61	117.200	299.5207
531	61	117.440	299.6618
532	60	117.680	299.8027
533	60	117.920	299.9436
534	60	118.160	300.0842
535	60	118.400	300.2248
536	59	118.640	300.3649
537	59	118.880	300.5051
538	59	119.120	300.6450
539	58	119.360	300.7849
540	58	119.600	300.9243
541	58	119.840	301.0639
542	58	120.080	301.2033
543	57	120.320	301.3425
544	57	120.560	301.4816
545	57	120.800	301.6203
546	56	121.040	301.7592
547	56	121.280	301.8977
548	56	121.520	302.0363
549	56	121.760	302.1745
550	55	122.000	302.3127
551	55	122.240	302.4506
552	55	122.480	302.5886
553	55	122.720	302.7260
554	54	122.960	302.8637
555	54	123.200	303.0009
556	54	123.440	303.1384
557	53	123.680	303.2753
558	53	123.920	303.4123
559	53	124.160	303.5490
560	53	124.400	303.6860
561	52	124.640	303.8222
562	52	124.880	303.9587
563	52	125.120	304.0952
564	52	125.360	304.2312
565	51	125.600	304.3671
566	51	125.840	304.5029
567	51	126.080	304.6386
568	50	126.320	304.7739
569	50	126.560	304.9094
570	50	126.800	305.0446
571	50	127.040	305.1799
572	49	127.280	305.3146
573	49	127.520	305.4494
574	49	127.760	305.5842
575	49	128.000	305.7187
576	48	128.240	305.8532
577	48	128.480	305.9873
578	48	128.720	306.1215
579	47	128.960	306.2553
580	47	129.200	306.3894
581	47	129.440	306.5229
582	47	129.680	306.6567
583	46	129.920	306.7900
584	46	130.160	306.9235
585	46	130.400	307.0566
586	46	130.640	307.1896
587	45	130.880	307.3225
588	45	131.120	307.4555
589	45	131.360	307.5881
590	45	131.600	307.7207
591	44	131.840	307.8530

592	44	132.080	307.9853
593	44	132.320	308.1174
594	44	132.560	308.2492
595	43	132.800	308.3813
596	43	133.040	308.5129
597	43	133.280	308.6445
598	42	133.520	308.7758
599	42	133.760	308.9074
600	42	134.000	309.0385
601	42	134.240	309.1699
602	41	134.480	309.3007
603	41	134.720	309.4316
604	41	134.960	309.5622
605	41	135.200	309.6928
606	40	135.440	309.8232
607	40	135.680	309.9536
608	40	135.920	310.0839
609	40	136.160	310.2138
610	39	136.400	310.3439
611	39	136.640	310.4738
612	39	136.880	310.6035
613	39	137.120	310.7331
614	38	137.360	310.8625
615	38	137.600	310.9919
616	38	137.840	311.1210
617	37	138.080	311.2504
618	37	138.320	311.3791
619	37	138.560	311.5080
620	37	138.800	311.6369
621	36	139.040	311.7656
622	36	139.280	311.8940
623	36	139.520	312.0224
624	36	139.760	312.1508
625	35	140.000	312.2788
626	35	140.240	312.4067
627	35	140.480	312.5349
628	35	140.720	312.6625
629	34	140.960	312.7902
630	34	141.200	312.9179
631	34	141.440	313.0451
632	34	141.680	313.1726
633	33	141.920	313.2998
634	33	142.160	313.4270
635	33	142.400	313.5539
636	33	142.640	313.6809
637	32	142.880	313.8076
638	32	143.120	313.9340
639	32	143.360	314.0607
640	32	143.600	314.1872
641	31	143.840	314.3134
642	31	144.080	314.4396
643	31	144.320	314.5656
644	31	144.560	314.6918
645	30	144.800	314.8176
646	30	145.040	314.9431
647	30	145.280	315.0690
648	30	145.520	315.1943
649	29	145.760	315.3200
650	29	146.000	315.4453
651	29	146.240	315.5703
652	29	146.480	315.6955
653	28	146.720	315.8203
654	28	146.960	315.9455
655	28	147.200	316.0700
656	28	147.440	316.1945
657	27	147.680	316.3193

658	27	147.920	316.4436
659	27	148.160	316.5678
660	27	148.400	316.6921
661	26	148.640	316.8161
662	26	148.880	316.9404
663	26	149.120	317.0642
664	26	149.360	317.1877
665	25	149.600	317.3117
666	25	149.840	317.4353
667	25	150.080	317.5586
668	25	150.320	317.6821
669	24	150.560	317.8054
670	24	150.800	317.9284
671	24	151.040	318.0515
672	24	151.280	318.1743
673	23	151.520	318.2973
674	23	151.760	318.4201
675	23	152.000	318.5427
676	23	152.240	318.6652
677	22	152.480	318.7875
678	22	152.720	318.9099
679	22	152.960	319.0322
680	22	153.200	319.1542
681	21	153.440	319.2763
682	21	153.680	319.3984
683	21	153.920	319.5200
684	21	154.160	319.6416
685	20	154.400	319.7634
686	20	154.640	319.8850
687	20	154.880	320.0063
688	20	155.120	320.1276
689	20	155.360	320.2490
690	19	155.600	320.3698
691	19	155.840	320.4912
692	19	156.080	320.6120
693	19	156.320	320.7329
694	18	156.560	320.8535
695	18	156.800	320.9741
696	18	157.040	321.0949
697	18	157.280	321.2153
698	17	157.520	321.3354
699	17	157.760	321.4560
700	17	158.000	321.5759
701	17	158.240	321.6960
702	16	158.480	321.8159
703	16	158.720	321.9357
704	16	158.960	322.0556
705	16	159.200	322.1752
706	15	159.440	322.2949
707	15	159.680	322.4143
708	15	159.920	322.5334
709	15	160.160	322.6530
710	14	160.400	322.7722
711	14	160.640	322.8911
712	14	160.880	323.0104
713	14	161.120	323.1291
714	14	161.360	323.2480
715	13	161.600	323.3669
716	13	161.840	323.4853
717	13	162.080	323.6040
718	13	162.320	323.7224
719	12	162.560	323.8408
720	12	162.800	323.9589
721	12	163.040	324.0771
722	12	163.280	324.1953
723	11	163.520	324.3132

724	11	163.760	324.4311
725	11	164.000	324.5490
726	11	164.240	324.6667
727	10	164.480	324.7844
728	10	164.720	324.9020
729	10	164.960	325.0195
730	10	165.200	325.1367
731	9	165.440	325.2541
732	9	165.680	325.3713
733	9	165.920	325.4882
734	9	166.160	325.6052
735	9	166.400	325.7224
736	8	166.640	325.8391
737	8	166.880	325.9558
738	8	167.120	326.0727
739	8	167.360	326.1892
740	7	167.600	326.3056
741	7	167.840	326.4218
742	7	168.080	326.5383
743	7	168.320	326.6545
744	6	168.560	326.7705
745	6	168.800	326.8869
746	6	169.040	327.0026
747	6	169.280	327.1186
748	6	169.520	327.2343
749	5	169.760	327.3503
750	5	170.000	327.4658
751	5	170.240	327.5812
752	5	170.480	327.6967
753	4	170.720	327.8122
754	4	170.960	327.9272
755	4	171.200	328.0424
756	4	171.440	328.1577
757	3	171.680	328.2727
758	3	171.920	328.3876
759	3	172.160	328.5024
760	3	172.400	328.6174
761	3	172.640	328.7321
762	2	172.880	328.8466
763	2	173.120	328.9614
764	2	173.360	329.0756
765	2	173.600	329.1901
766	1	173.840	329.3041
767	1	174.080	329.4187
768	1	174.320	329.5327
769	1	174.560	329.6467
770	0	174.800	329.7607
771	0	175.040	329.8747
772	0	175.280	329.9885
773	0	175.520	330.1020
774	0	175.760	330.2155
775	0	176.000	330.3293
776	0	176.240	330.4428
777	0	176.480	330.5561
778	0	176.720	330.6694
779	0	176.960	330.7829
780	0	177.200	330.8959
781	0	177.440	331.0090
782	0	177.680	331.1220
783	0	177.920	331.2351
784	0	178.160	331.3479
785	0	178.400	331.4606
786	0	178.640	331.5732
787	0	178.880	331.6860
788	0	179.120	331.7983
789	0	179.360	331.9108

790	0	179.600	332.0231
791	0	179.840	332.1357
792	0	180.080	332.2478
793	0	180.320	332.3598
794	0	180.560	332.4719
795	0	180.800	332.5842
796	0	181.040	332.6960
797	0	181.280	332.8078
798	0	181.520	332.9194
799	0	181.760	333.0314
800	0	182.000	333.1430
801	0	182.240	333.2543
802	0	182.480	333.3659
803	0	182.720	333.4772
804	0	182.960	333.5886
805	0	183.200	333.6999
806	0	183.440	333.8110
807	0	183.680	333.9221
808	0	183.920	334.0332
809	0	184.160	334.1440
810	0	184.400	334.2548
811	0	184.640	334.3657
812	0	184.880	334.4765
813	0	185.120	334.5871
814	0	185.360	334.6977
815	0	185.600	334.8081
816	0	185.840	334.9184
817	0	186.080	335.0290
818	0	186.320	335.1391
819	0	186.560	335.2495
820	0	186.800	335.3596
821	0	187.040	335.4694
822	0	187.280	335.5798
823	0	187.520	335.6894
824	0	187.760	335.7995
825	0	188.000	335.9091
826	0	188.240	336.0190
827	0	188.480	336.1286
828	0	188.720	336.2380
829	0	188.960	336.3476
830	0	189.200	336.4570
831	0	189.440	336.5664
832	0	189.680	336.6757
833	0	189.920	336.7849
834	0	190.160	336.8940
835	0	190.400	337.0029
836	0	190.640	337.1120
837	0	190.880	337.2209
838	0	191.120	337.3298
839	0	191.360	337.4384
840	0	191.600	337.5473
841	0	191.840	337.6560
842	0	192.080	337.7646
843	0	192.320	337.8730
844	0	192.560	337.9814
845	0	192.800	338.0898
846	0	193.040	338.1984
847	0	193.280	338.3066
848	0	193.520	338.4147
849	0	193.760	338.5227
850	0	194.000	338.6306
851	0	194.240	338.7387
852	0	194.480	338.8466
853	0	194.720	338.9545
854	0	194.960	339.0622
855	0	195.200	339.1699

856	0	195.440	339.2779
857	0	195.680	339.3852
858	0	195.920	339.4926
859	0	196.160	339.6000
860	0	196.400	339.7072
861	0	196.640	339.8149
862	0	196.880	339.9221
863	0	197.120	340.0290
864	0	197.360	340.1362
865	0	197.600	340.2431
866	0	197.840	340.3500
867	0	198.080	340.4572
868	0	198.320	340.5639
869	0	198.560	340.6708
870	0	198.800	340.7775
871	0	199.040	340.8840
872	0	199.280	340.9907
873	0	199.520	341.0974
874	0	199.760	341.2036
875	0	200.000	341.3100
876	0	200.240	341.4162
877	0	200.480	341.5224
878	0	200.720	341.6289
879	0	200.960	341.7351
880	0	201.200	341.8410
881	0	201.440	341.9470
882	0	201.680	342.0529
883	0	201.920	342.1586
884	0	202.160	342.2646
885	0	202.400	342.3703
886	0	202.640	342.4760
887	0	202.880	342.5815
888	0	203.120	342.6870
889	0	203.360	342.7924
890	0	203.600	342.8981
891	0	203.840	343.0036
892	0	204.080	343.1088
893	0	204.320	343.2141
894	0	204.560	343.3190
895	0	204.800	343.4243
896	0	205.040	343.5295
897	0	205.280	343.6345
898	0	205.520	343.7392
899	0	205.760	343.8442
900	0	206.000	343.9489
901	0	206.240	344.0537
902	0	206.480	344.1584
903	0	206.720	344.2631
904	0	206.960	344.3676
905	0	207.200	344.4721
906	0	207.440	344.5764
907	0	207.680	344.6809
908	0	207.920	344.7854
909	0	208.160	344.8896
910	0	208.400	344.9938
911	0	208.640	345.0979
912	0	208.880	345.2019
913	0	209.120	345.3059
914	0	209.360	345.4099
915	0	209.600	345.5139
916	0	209.840	345.6179
917	0	210.080	345.7216
918	0	210.320	345.8251
919	0	210.560	345.9289
920	0	210.800	346.0324
921	0	211.040	346.1359

922	0	211.280	346.2397
923	0	211.620	346.3430
924	0	211.760	346.4465
925	0	212.000	346.5498
926	0	212.240	346.6528
927	0	212.480	346.7561
928	0	212.720	346.8591
929	0	212.960	346.9624
930	0	213.200	347.0654
931	0	213.440	347.1684
932	0	213.680	347.2712
933	0	213.920	347.3742
934	0	214.160	347.4770
935	0	214.400	347.5795
936	0	214.640	347.6826
937	0	214.880	347.7851
938	0	215.120	347.8876
939	0	215.360	347.9899
940	0	215.600	348.0925
941	0	215.840	348.1948
942	0	216.080	348.2971
943	0	216.320	348.3994
944	0	216.560	348.5019
945	0	216.800	348.6040
946	0	217.040	348.7060
947	0	217.280	348.8081
948	0	217.520	348.9101
949	0	217.760	349.0119
950	0	218.000	349.1137
951	0	218.240	349.2160
952	0	218.480	349.3176
953	0	218.720	349.4194
954	0	218.960	349.5209
955	0	219.200	349.6225
956	0	219.440	349.7241
957	0	219.680	349.8256
958	0	219.920	349.9270
959	0	220.160	350.0283
960	0	220.400	350.1298
961	0	220.640	350.2312
962	0	220.880	350.3325
963	0	221.120	350.4335
964	0	221.360	350.5346
965	0	221.600	350.6357
966	0	221.840	350.7368
967	0	222.080	350.8376
968	0	222.320	350.9387
969	0	222.560	351.0395
970	0	222.800	351.1403
971	0	223.040	351.2409
972	0	223.280	351.3417
973	0	223.520	351.4423
974	0	223.760	351.5429
975	0	224.000	351.6435
976	0	224.240	351.7438
977	0	224.480	351.8444
978	0	224.720	351.9448
979	0	224.960	352.0451
980	0	225.200	352.1455
981	0	225.440	352.2456
982	0	225.680	352.3457
983	0	225.920	352.4458
984	0	226.160	352.5458
985	0	226.400	352.6457
986	0	226.640	352.7460
987	0	226.880	352.8459

988	0	227.120	352.9458
989	0	227.360	353.0454
990	0	227.600	353.1452
991	0	227.840	353.2448
992	0	228.080	353.3444
993	0	228.320	353.4440
994	0	228.560	353.5434
995	0	228.800	353.6430
996	0	229.040	353.7426
997	0	229.280	353.8420
998	0	229.520	353.9414
999	0	229.760	354.0407
1000	0	230.000	354.1398
1001	0	230.240	354.2390
1002	0	230.480	354.3381
1003	0	230.720	354.4372
1004	0	230.960	354.5361
1005	0	231.200	354.6352
1006	0	231.440	354.7343
1007	0	231.680	354.8332
1008	0	231.920	354.9321
1009	0	232.160	355.0307
1010	0	232.400	355.1296
1011	0	232.640	355.2282
1012	0	232.880	355.3266
1013	0	233.120	355.4252
1014	0	233.360	355.5239
1015	0	233.600	355.6223
1016	0	233.840	355.7207
1017	0	234.080	355.8193
1018	0	234.320	355.9177
1019	0	234.560	356.0158
1020	0	234.800	356.1140
1021	0	235.040	356.2124
1022	0	235.280	356.3103
1023	0	235.520	356.4084